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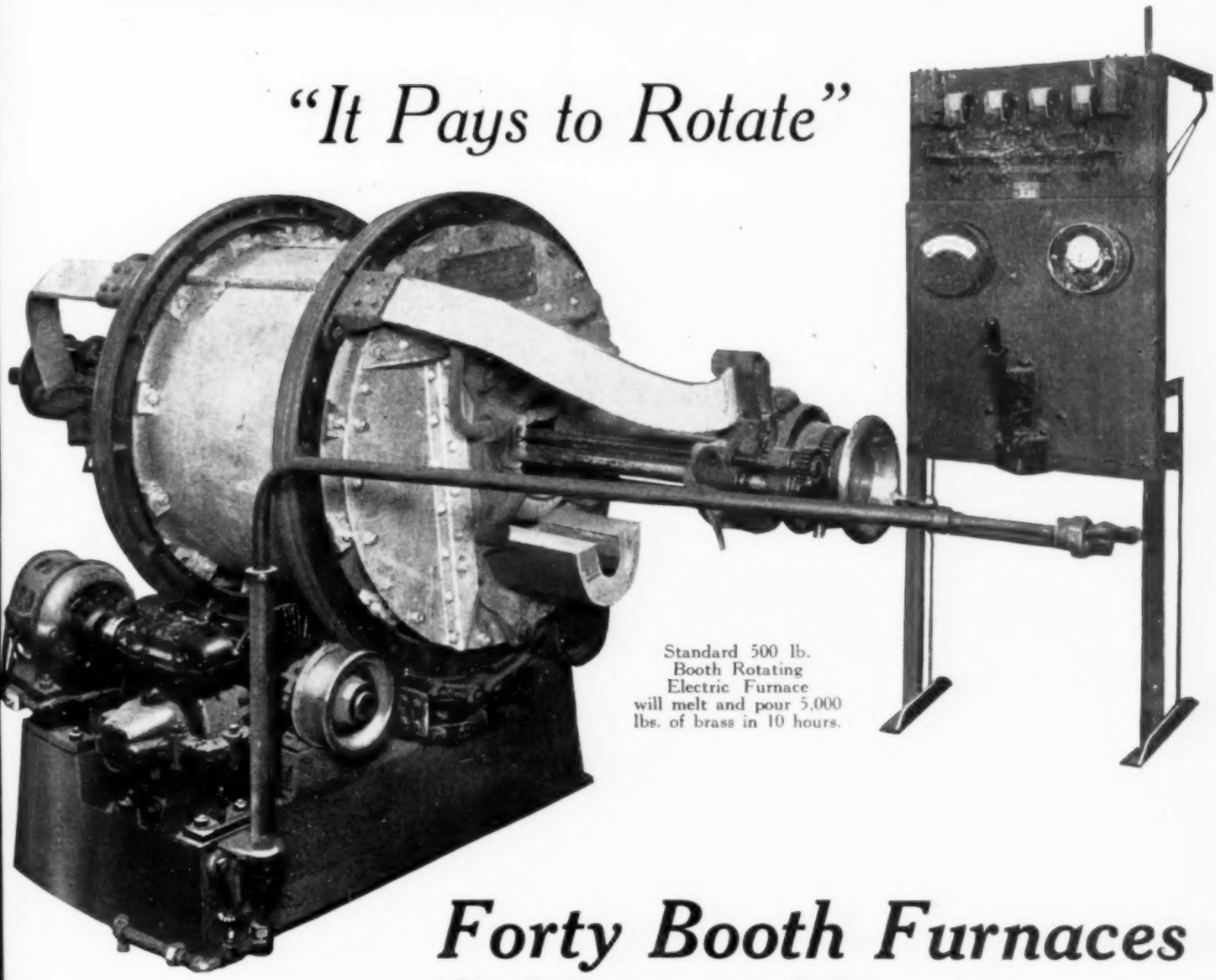
CHEMICAL & METALLURGICAL ENGINEERING

"It Pays to Rotate"



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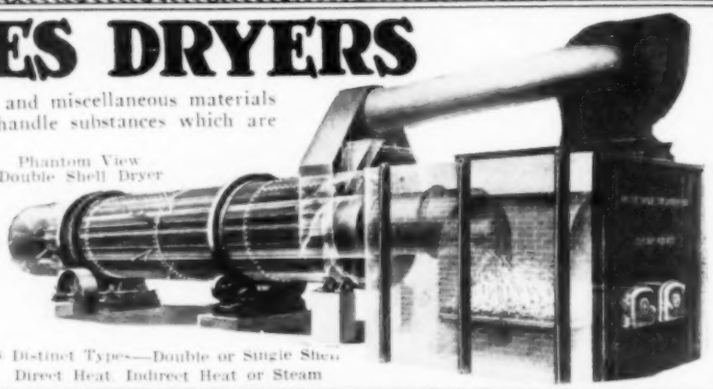

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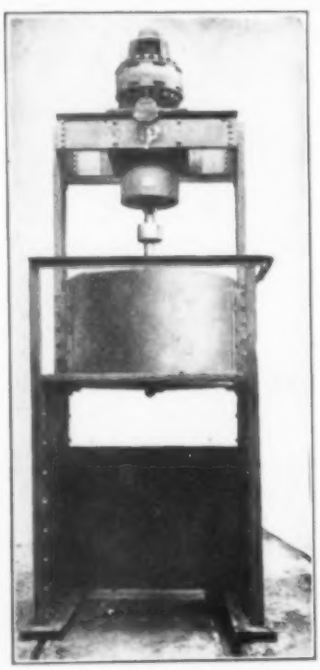

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Reconstruction the Theme For A. C. S. Chicago Meeting

INCREASED production through chemistry, and the part which the science can play in the reconstruction of our industries, is to be the theme of the Chicago meeting of the American Chemical Society in September. The topic is timely and should develop some valuable suggestions for those whose chemical control of manufacture has not yet reached the highest development. There is scarcely an industry of any magnitude in which chemistry does not play a part of greater or less importance. And those are few, no matter how highly developed, that cannot profit by looking ahead and giving thought to the improvements that will follow the adoption of better technology. In fact, a casual survey of the largest and most prosperous of our industries will reveal a lively appreciation of the value of chemistry and allied sciences.

If there is one lesson we can learn from our late enemy—who technically still occupies that unhappy position—it is the wisdom of co-ordinating the science of chemistry with the operations of industry. Notwithstanding popular impressions to the contrary, Germany is not noted for fundamental contributions to chemistry. Read the history of the science, and you will search almost in vain for the names of Germans who lifted chemistry out of the realm of crude speculation and placed it on a sound theoretical basis. English, French, Scandinavians were the pioneer thinkers. But none has been quite so industrious as the German in applying to manufacture the fundamental facts developed by others. This is one of the outstanding features in Germany's industrial growth; and if the noblest use has not always been made of it, other national traits must be called to account. Anyhow the lesson is there and may well be learned.

The forward-looking and progressive slogan adopted for the chemists at Chicago is in curious contrast to the reactionary tendencies evident in our political life. There is much talk in conventions and by candidates for high office of a return to pre-war conditions in methods of government and party control. Faith is expressed in the doctrines of the fathers; reliance is placed in tried methods; and confidence reposes not in a new day but in the old. Chemistry, on the other hand, has its face to the rising sun and places its hope in the new things it can do for sound reconstruction.

Incidentally, it is worth while noting the plans which the local committees of the American Chemical Society are making for the Chicago meeting. Profiting by past experience in other cities, they are showing commendable initiative in arranging for technical sessions and social functions under the most favorable conditions. The tentative plans published in our last issue are an earnest of what may be expected in September

An Organization Of Potential Influence

ENGINEERS often tell themselves, or are often told by non-technical admirers, that as a profession they are not exerting an influence upon human activity as wide as they deserve. Without wishing to set themselves up as persons who could do almost anything better than the fellow who is doing it, engineers can therefore be pardoned for hoping that the newly formed Federated American Engineering Societies can quickly bring the best trained talent to focus on a subject of economic importance and then present the decision with all the prestige and ability inherent in a united body of men of recognized intelligence. The public in general is impressed by the ability underlying the many engineering triumphs daily serving its comfort and convenience; it now remains to capitalize this prestige in a nation-wide organization.

However, these ideas are almost always nebulous, and the words which usually express them clothe glittering generalities. "What can a Federation of Engineering Societies do? Give me something specific" will be insisted by many of the more practical among us. Even when definite tasks are proposed many of them seem of very narrow gage.

ARTHUR P. DAVIS, the President of the American Society of Civil Engineers and Director of the U. S. Reclamation Service, has mentioned one instance drawn from recent history which may appeal to some as indicating the way in which a national engineering organization may really be most useful. That is to say, since the problems before that body are at present somewhat indefinite it would be well worth the effort of its creation and maintenance as a being of potentiality, capable of exerting large influence on short call.

Older engineers can remember the agitation in favor of the Nicaragua Canal—a diligent agitation carried on for many years by men of national prominence. Even after this Government was bound by treaty to construct the Panama Canal, bills favoring Nicaragua were year after year introduced into Congress, and pressed with all the devices of skilled lobbyists.

The matter finally came to a point where it was referred to three engineers for a technical opinion, Messrs. LUDLOW, NOBLE and ENDICOTT. The work they did in that connection will ever be known as a most honorable achievement. With an appropriation so insufficient that these men had to forego their compensation and still have but a fraction of the funds necessary for thorough investigation, they devoted themselves with sufficient energy and persistence to show that the Nicaraguan scheme was full of glaring blunders, that many proposals were clearly unworkable and that the plan had received millions for promotion to thousands for investigation.

These three men were strong and brave enough to set these facts before the American people. Their work was directly responsible for a second commission backed by an appropriation fifteen or twenty times as large as the original, which even yet was supplemented as entirely inadequate. Finally the Panama route was investigated in detail, and after all the influence that malice and malignity or honest and well-meaning opposition could bring to bear the American Government was saved from a blunder and failure at Nicaragua beside which the best French attempt at Panama would have been a pigmy.

LUDLOW, NOBLE and ENDICOTT did their work almost unassisted. Naturally, there were many supporters in the technical and daily press, and among the more responsible Congressmen and Government officials—without which, of course, they could not have gone very far. But how much better would it have been if the entire engineering profession had been behind them, with every resource of a complete organization! Under such circumstances they unquestionably could have accomplished the task which was finally done, although often perilously near failure, with half the effort, risk and self-denial.

Other tasks, more important and more insistent for correct performance, will arise from time to time before the American Engineer. He will do well to note how successful HERBERT HOOVER was when as food controller and relief administrator he was backed by a closely knit organization. What could have been done by even Mr. HOOVER without such support?

Science, Population And Means of Subsistence

WHEN at the close of the eighteenth century the English economist THOMAS ROBERT MALTHUS wrote his Essay on Population he might have been justified in lamenting the misfortunes consequent on the tendency of population to increase faster than the means of subsistence, though at the present time it would seem preposterous to admit that population increases in a geometrical ratio while means of subsistence increases only in an arithmetical ratio. In his time little was known of the powers of chemistry, and the natural wealth of the populated areas, small as they were, was scarcely realized. The toilers of the soil prayed for rain and good crops instead of working out their own salvation by the application of scientific methods. Since that time necessity has been a great incentive toward balancing the increase of population with the food supply and other needed accessories, and has resulted in great strides in scientifically reclaiming waste areas, chemically stimulating returns from the soil, methodically working the natural raw products, and especially using the hitherto practically useless raw material supplies from different parts of the world. Relatively little progress has been made up to this time, but the little already accomplished has given excellent results, so that food production stoutly keeps pace with the increase of population.

How much more might be expected can be surmised from an analysis of the contribution of all branches of science and engineering to the welfare of humanity, and from a better knowledge of economic geography as typified by the phenomenally rapid progress of the United States since MALTHUS' time; nor is our country a unique exception. Following closely in the steps of the guardian nation comes the community of the Philippine Islands, which up to a few decades ago was a territory practically unknown to the rest of the world. First-hand information about the current economic status of this region contributed by Dr. ALVIN J. COX, in our last issue, may be taken as typical of similar descriptions which might be made of the resources of other parts of the Australasian and African continents. It shows that the natural heritage of the human race, when used in accordance with scientific and engineering principles, is and will be amply sufficient at all times to meet the necessities and luxuries of life.

MALTHUS was right in his time, but he lacked light and vision.

Utilization of Oxygen in Non-Ferrous Metallurgy

AMONG the more important developments in non-ferrous metallurgy have been new methods or improvements in old methods of ore concentration. These have resulted in changes as to both type and design of metallurgical furnaces. Of importance also is the recovery of byproducts, hastened perhaps by the necessity of removing deleterious impurities from smelter gases as a result of smoke-damage suits but receiving additional impetus as the value of these byproducts has increased or as methods have been devised for their economical utilization. Many of the larger plants are now producing sulphuric acid, the Tacoma smelter is producing liquid sulphur dioxide, and there are several plants at which arsenic is recovered. A further step in advance may result from the use of oxygen to enrich the gases supplied to metallurgical furnaces—in other words, from the concentration of the gases as well as the ores.

The utilization of oxygen in this manner has been the dream of chemists and metallurgists. The late J. E. JOHNSON, JR., pointed out the advantages of oxygen-enriched gases in iron blast-furnace operation, predicting the necessity of its use as the grade of available ores decreased; and F. G. COTTRELL has frequently and forcibly called attention to the desirability and practicability of enriching gases with oxygen in the non-ferrous metallurgical furnaces. Some inconclusive experiments were carried out in Belgium before the war, which, with JOHNSON'S, are probably the only tests that have been conducted up to the present.

That the use of oxygen in metallurgical operations is receiving serious attention, on the part of some metallurgists at least, is evidenced by the patent recently granted to FREDERICK LAIST and FREDERICK F. FRICK of the Anaconda Copper Company's staff. At Anaconda a large quantity of sulphur dioxide is produced, all of which cannot be converted into sulphuric acid, as it is improbable that a market could be found for the product. On the other hand, there is a market for liquid sulphur dioxide and for sulphur. The dilute sulphur dioxide gases from ordinary furnace operations cannot easily be liquefied or converted into sulphur. If, however, the concentration of the sulphur dioxide of these gases can be increased, both of these operations are simplified and become economically possible. In order to obtain a gas containing a larger proportion of sulphur dioxide it is proposed to replace the air supplied to the furnaces by a mixture of oxygen and sulphur dioxide. The exit gases from a furnace would

consist principally of sulphur dioxide. A portion of this gas would be returned to the furnace and enriched with a regulated amount of oxygen in order to avoid the intense action of pure oxygen on the sulphide materials. The remainder of the exit gases can either be compressed for the production of liquid sulphur dioxide or be treated with carbonaceous material in a suitable apparatus for the production of sulphur.

It is true in this instance that oxygen is to be used to accomplish a particular result and that the advantages to be gained by its use in the operation of the furnace are in the nature of secondary consideration. Yet it is to be hoped that the experiment will be tried, as it would be conducted under favorable circumstances and if successful would hasten an important metallurgical development.

Utilizing Lower Grade Iron Ores

AS HAS been well known for a long time, the total quantity of iron-bearing material in the earth's crust is very large, the iron content of material that is moderately well known being probably dozens of times the amount of iron that has actually been produced in the world to date. About fifteen years and more ago much interest was exhibited in certain quarters over "the world's supplies of iron ores" and studies were made indicating that the supplies of "iron ore" were relatively limited, usually involving a life measured only by decades. Most of these studies were made from an objectionable viewpoint—that of regarding the iron ore of the future as definable by existing standards. In many cases what is the waste material of one time becomes the mineral of another. In the case of iron-bearing material this is particularly true. Indeed, on account of the low value and great weight involved, there have been contemporary cases of this sort. At no time in the past would the iron ore of Alabama be iron ore if found in Sweden. The Swedish industry, using first charcoal only and later charcoal and electricity, required a rich material, which it had or produced by concentration. The blast furnaces that used the early pickings from the Lake Superior region would not have regarded as ore the material that has since been utilized in hundreds of millions of tons from the Minette district of Europe.

What the studies referred to really indicated was that as time passed lower and lower grade material would have to be used as iron ore. Even though in iron ore explorations little attention has been paid to the iron-bearing material that was not classifiable at the time as iron ore, it has always been the case that the known material below the ore limit was many times greater than the known material then classed as ore.

The Lake Superior region now stands in the delicate position of having its future depend upon the processes men develop and apply for beneficiating iron ore. The present known reserves in the region meeting the present standard are sufficient for only from fifteen to thirty years, according to various estimates made, but iron and steel are likely to be made for an indefinite time in the future. The various districts will be in competition. If the Lake Superior region develops sufficiently cheap means for beneficiating its low-grade material, it will survive the competition with the ore of the South and other districts in the United States as well as the competition of the rich ores of various foreign countries. Utilization of one material or another by blast furnaces, or whatever appliances are employed to make the merchantable product, will depend upon costs. The absolute cost will have nothing to do with the matter. Particularly on account of experiences of the past few years, it is plain that a difference of a few dollars a ton in the cost of steel means nothing as to regulating the quantity consumed, but even a very few dollars a ton is a great deal with iron ore.

Each district will have its own problems. There will be no solution open to all districts, to be utilized by each according to its degree of enterprise. In the case of Chilean and other far off but rich deposits, the chief matter will be one of cheap transport. With Lake Superior it will be a matter of cheap concentration, on the ground, since the ore must travel long distances and the methods of transportation cannot be very greatly improved upon. With Alabama it will be a matter of more economical methods of mining iron ore and producing coke, and so with all districts in the competition that is to come. Not so much the present geological conditions, but rather what men do, will determine the relative importance of the various iron ore districts a quarter century from now.

The Factors Influencing the Adhesive Properties of Glues

EVER since the time of PETER COOPER the question of grading glues has been an open one and free to individual opinion. The "Cooper Standards" have been used in commerce so long that they may be regarded as venerable and valuable antiques to be continued in use as long as the trade will stand for them, or until it is known just what glue is and what it isn't—a time which appears a long way off even today.

Undoubtedly the reader who has been interested in and following the articles on the Properties and Constitution of Glues and Gelatines in the first five issues of the present volume has come to the conclusion that the author has not spent three years of his time in a vain research. Dr. BOGUE has studied the factors influencing viscosity and jell strength, which in turn have long been established as functions of the adhesive properties of glues. He finds that vigorous agitation and prolonged heating tend to break up the physical structure and give a glue of less viscosity and strength. Dehydration if carried far enough produces a reversion of gelatine to an insoluble form called collagen. The effect of electrolytes is largely dielectric. The most probable structure of the colloid glue aggregate is streptococcal. The action of low-grade bone glues in crazing upon drying out thoroughly is due to the non-glue protein content, which does not reduce the vapor pressure of the required water solvent of solid solution to that of the atmosphere.

In commercial interest the outstanding feature is the recommendation that glues be evaluated by a melting-point test. The author demonstrates in the present issue that many errors now prevalent in the viscosity and jell-strength tests can be entirely avoided by a simple melting-point determination. In the final analysis the tensile and shear-strength tests are what the user wants to know, but he cannot take the time such tests require. In a measure, if his product sticks together he can feel assured that the glue he used was at least good enough, but apparently the melting-point test offers considerably more certainty and should therefore be widely adopted.

Readers' Views and Comments

Science the Desecrator

To the Editor of Chemical & Metallurgical Engineering

SIR:—You may have noted that the ubiquitous tinkers have again resurrected the vacuous proposal to mend the Liberty Bell. This time it is aired at length in the *Public Ledger*, and sent broadcast in a pearl of newspaper English by that estimable journal the *Literary Digest*, whose perspicacity in things relating to Science and Invention is attested by its occasional use of my own contributions to your estimable columns.

Passing over an evident play for publicity on the part of some men engaged in welding, the proposal is to mend the crack by arc-welding. In the words of the newspaper:

> They would proceed in this fashion: Take first a grain of metal from the crevice of the bell. Have it analyzed by a board of expert metallurgists. Reproduce in the laboratories of the alchemist the identical metal of which the Liberty Bell is composed. When you have the proper alloy you are ready to bring on the electric needle.

Was it Berzelius or was it Stas who was able to obtain the chemical formula for a minute fragment of an unknown mineral? But they are dead. Hence the use of the "board"—ouija board probably is meant. For these expert "metallurgists" would undoubtedly need advice as to how to perform the analysis, being unused to the routine of such work themselves, and unhappily not being able to rely upon Ramsay, that most genial experimenter. But before getting started it would doubtless occur to some of the experts (other than welding experts) who might have sampled a goldmine somewhere that the bell was cast some years before the advent of large melting furnaces, and is the product of at least two dozen crucibles, and each portion had been remelted twice by amateurs, with attendant doctoring! You will agree with me, Mr. Editor, that the alchemist would indeed be needed to reproduce the "identical metal."

> Now for the process of welding. Fashion the new metal to be applied into a wire or needle of the welding apparatus. Measure the resistance of the bell and the resistance of the wire after having estimated the amount of steel to fill up the crack. Now to fill in the crack . . . The Liberty Bell is mended just as the surgeon takes a piece of bone from the shin and grafts t on the face to make a new nose—bone for bone and, in this case, metal for metal.

"Steel," did he say? Indeed a strange bell must be this Liberty Bell, well worthy of mending! But he writes prettily, so why be meticulous?

> It is asserted by the welders that electricity will also cure the famous bell of its chronic disease. The bell's doctor . . . has held that the bell suffers from a form of distemper. It is to be guarded carefully lest it go all to pieces.
>
> The electrical engineers now prescribe baths for the bell—electrical baths. Heat it electrically and then allow it to cool slowly. This will eliminate the fatigue of the metal. The heat treatment is recommended regardless of the proposed transfusion. The heat, it is reasoned, would preserve the bell by relieving the stress between the metal particles caused by vibration. Constant vibration wears against the relic particularly when it is opened to visitors, as in the recent case when the Spanish novelist, Vicente Blasco Ibañez, clasped and kissed it.

Enough to make even a bell tired!

And so on and so on. Fortunately others than progressive welders are to be consulted before "the invalid bell, with its supposedly fatal wound, shall be summoned into the electric clinic—or left to its fate"! Would not any fate, Mr. Editor, be as good as the electric chair?

I will not impose on your good nature by pointing out in detail what is probably well known to all interested persons except newspaper writers—who evidently do not need to know: that no attempt is made to get an electrode of the same chemical composition as the metal to be welded; that the deposit is changed considerably from its original analysis by the intense temperature; that sound fusion welds cannot be made in bronzes such as bell metal, because the low-melting beta or gamma constituent boils out of the pasty alpha matrix, leaving a veritable honeycomb, and that closed structures of any sort are particularly hard to weld, because upon cooling shrinkage strains are almost sure to reopen the defect.

But for the information of any American who wishes the Old Bell to be preserved against the ravages of time and electrical experimenters it may be confidently stated that the old crack which destroyed the bell's somewhat raucous voice, but thereby canonized it, as well as the new crack discovered about ten years ago, is probably due to the relief of casting or cooling strains, existing in all such pieces, and mitigated ordinarily by careful annealing. Further extension of these defects has been prevented by the late J. Sellers Bancroft, who constructed a concealed spider whose fingers clasp the rim of the bell and are drawn to a central rod by turnbuckles, the whole contrivance being so arranged as to throw compression into that portion of the casting which had split under tensile stresses.

Rest in peace! MARTIN SEYT.

Cleaning Up Mexico—With Soap

To the Editor of Chemical & Metallurgical Engineering

SIR:—I was much interested in reading your editorial in the issue of June 16 respecting the large importation of soap into Mexico. I have wondered if you thought there might have been ulterior motives in securing such a large quantity of material not usually associated with our ideas of the Mexicans (although I can assure you that there are Mexicans thoroughly familiar with the use of soap and its intended functions).

Only yesterday, however, I was informed by a man recently returned from Mexico that soap was being used for the secret shipment of ammunition in various sections of Mexico; the practice being to slip cartridges into cakes of soap which were then returned to their original boxes and shipped as "soap" to various sections of the country where ammunition was deemed most useful; the boxes with the empty cakes of soap being "returned" to the original point of shipment for fresh loading with cartridges. I cannot vouch for the accuracy of this statement, but it seemed to fit very well with your statement respecting the unusual amount of soap imported by Mexico. MURRAY C. BOYER

Philadelphia, Pa.

British Chemical Industry

(FROM OUR LONDON CORRESPONDENT)

London, July 9, 1920.

SIGNS are not wanting that in common with many other industries in this country, the chemical industry is passing through a transition period in an atmosphere charged with considerable anxiety. Labor unrest is, of course, still with us and is again causing nervousness, but the crucial question of the moment is undoubtedly that of transport. Increases in freight rates and more particularly demurrage charges and inordinate delays and uncertainties in regular deliveries of fuel and raw materials have greatly hampered production and regular output, especially in the case of the larger works. It is hoped that increasing use of road motor transport will ease the situation, and in the meanwhile the proposals of the Transport Ministry for the unification and co-ordination of railway traffic are viewed with scepticism. As regards labor unrest, a typical case is that of Van den Berghs, Ltd., margarine manufacturer, where a strike of the workers for an additional $4 a week has been firmly refused and the works closed for the time being. The present wages paid are already higher than those at any other factory in the district, while in addition the firm is noted for the excellence of its welfare work. This will perhaps be a test case and there can be little doubt that this example will be followed by many of the large employers of labor. The next few months should show whether the result will be a series of disastrous strikes and lockouts or the alternative—renewed confidence in the future of the country's trade.

COMMERCIAL DEVELOPMENTS

The annual reports of Explosives Trades, Ltd., and Brunner Mond & Co., Ltd., are of great interest, over 60 per cent of the former company's activities being now devoted to interests other than those suggested by its title and including various chemicals, candles, gas mantles, electric lamps, varnishes, metal goods, motor accessories, metal powder, welding and artificial leather. In addition, the company has acquired an interest in General Motors, Ltd., of America, British Dyestuffs Corporation and the British Cellulose Co. and has purchased the British Pluvinsine Co., of Manchester, manufacturing artificial leather. The Chemical & Dyestuffs Traders Association referred to in my last report (see CHEM. & MET. ENG., July 7) has taken offices at 22, Buckingham Gate, London, S. W. 1, and has already taken action with the government authorities in regard to excess profits duty and the status of the association under the Board of Trade. It is interesting to note that its rival, the British Chemical Trade Association, is now furnishing the market reports to the *Chemical Trade Journal*.

The possibilities of oxygen in connection with the carbonization of coal for gas production are attracting considerable attention and it is anticipated that, given a reasonably cheap source of supply as foreshadowed in the report of the Nitrogen Products Committee, considerable saving in fuel is possible together with increased efficiency in the utilization of the available supplies of coal. This problem should be of particular interest in America and other countries possessing adequate water-power resources which are being utilized for the manufacture of nitrogen from the air.

The supply of fertilizers is still inadequate, nearly all countries having recourse to export prohibitions or restrictions. The bearing of the projected developments in the Haber ammonia process has already been discussed, and in the meanwhile the supplies of foreign basic slag are increasing. Much attention is being paid to increased crop production based on scientific methods and the use of mechanical appliances. The electrical treatment of seeds by processes such as the "Wolfryn" process is coming into increasing use and with satisfactory results. The seeds are immersed in a weak solution of salt and a weak electric current is passed for a few hours. After carefully drying the seeds, it is found that on sowing, germination is more rapid and the increase in the crop varies from 20 to 30 per cent, while at the same time the yield of straw and immunity from disease are greatly increased. Arrangements are now being made for the exploitation of the process in all parts of the world and further experiments are to be undertaken in connection with its application to special classes of seeds used in tropical climates.

USES FOR SURPLUS AMMUNITION

In nearly all European countries hundreds of thousands of tons of surplus artillery ammunition are either awaiting disposal or are being broken up into their component parts. In this country the work is proceeding at the national filling factories, hot water being used to wash out the ammonium nitrate and to melt the TNT content in the amatol charge. Many ingenious devices and methods are being applied to the economical recovery of the brass, aluminum and other components. The ammonium nitrate has been largely used as a fertilizer, but so far no use has been made officially of the cordite or other propellant powders and the recovered TNT, these materials being at present merely burned. It is hoped in the near future to find a use for cordite, while it is reported that the TNT can be used as a fertilizer if applied in a sufficiently dilute form. The surplus ammunition in France, amounting to about half a million tons, has been sold to F. N. Pickett & Son, of Wimereux, while the corresponding arrangements in this country with George Cohen & Sons, of London, appear to be hanging fire. The problem of dealing with ammonal charges is probably more difficult than recovery from amatol and attempts are also being made to recover and utilize the saltpeter from the black powder charge of shrapnel shells. The chief problem in these factories is efficient organization and proper handling appliances together with careful physical control of the ammonium nitrate recovery process.

DINNER TO LORD MOULTON

A complimentary dinner is to be given this month to Lord Moulton in appreciation of the valuable services which he has rendered during the war as director general of explosives supplies at the Ministry of Munitions and in other capacities. It is possible that an announcement may be made at this dinner in regard to the scheme of the Federal Council of Learned and Scientific Societies for establishing a chemical headquarters in London and the details should have matured sufficiently by the end of the year to enable the plan to be launched at about the same time as the annual dinner of the Chemical Industry Club in November.

FIG. 1. LOOKING EAST AT DRY-END BUILDINGS

Cyanamide Process Plant at Muscle Shoals

Condensed Sketch of U. S. Nitrate Plant No. 2 Shown by Photographs and Flow Sheets—An Accomplishment Reflecting Credit Upon American Engineers and Builders—Now Stands Idle Awaiting Congressional Action on Government Operation Bill

BY CHESTER H. JONES

LOOKING backward through the facts and fiction about the nitrate situation in general and the cyanamide process as known in the United States through the Muscle Shoals plant in particular, it is noted that the fiction has obscured the truth as presented in the popular press, in the records of the Graham House committee, the report of the proceedings of the Senate Committee on Agriculture and Forestry, the politically colored report No. 998 by Mr. Graham of Illinois, and the subsequent discussions during the second session of the Sixty-sixth Congress. Even a careful perusal of these records by one unfamiliar with the character of the personnel of the conflicting interests would leave him in doubt as to whether the large property in Alabama is valuable or a mere heap of war-time waste. It is not the purpose of this article to enter into the political aspects but rather to show by the pictured fact that U. S. Nitrate Plant No. 2 is one of the largest chemical plants in the world, that it is for all practical purposes completed and that it is constructed in accordance with the best engineering practice. Laying aside the question of expenditures and motives attributed to its builders it is a marvelous achievement constructed in record time.

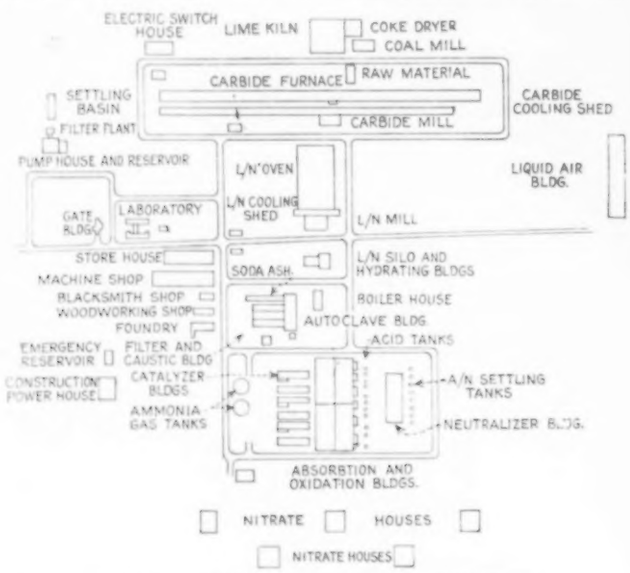


FIG. 2. PLAN OF PROCESS BUILDINGS

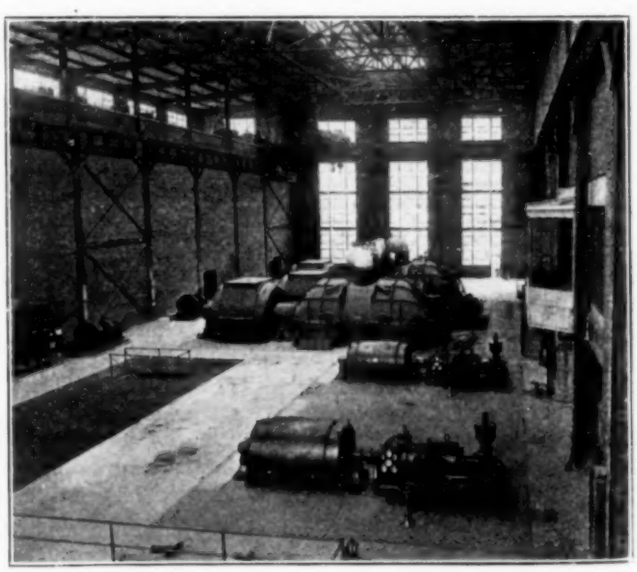


FIG. 3. TURBINE ROOM STEAM POWER PLANT

CHEMICAL & METALLURGICAL ENGINEERING, vol. 20, No. 1, dated Jan. 1, 1919, contains a most excellent article by Andrew M. Fairlie on the details of construction and operation written during the construction period, and the actual record of Government operating tests may be found in the July 15, 1919, issue.

Examination of the plan (Fig. 2) gives an idea of the extent of the process buildings, with the exception of the power plant, which lies about three-quarters of

FIG. 1 (CONTINUED). LOOKING EAST AT DRY-END BUILDINGS

a mile to the north of the electric switch house. The section which lies north of the hydrating building is known as the "dry end," while that on the south half is the "wet end" of the process. The flow of material is southward through the plant.

Reading from left to right in Fig. 1, the main power house stacks are visible through the trees. The next low building is the electric switch house, or main substation for the distribution of current to the various process substations. The seven steel stacks locate the limekilns and the twelve steel rectangular stacks are extensions of the hoods over the carbide furnaces. The next long building paralleling the furnaces is the cooling shed. Then comes the carbide mill, the lime nitrogen or cyanamide oven building, attached to the lower of which is seen the cooling shed and lime nitrogen mill. The storage silos and hydrating building are just beyond, but the wet-end buildings are better shown in Fig. 8.

The low buildings in the foreground at the left of this view are the shops, and the building with three monitors to the right is the filter plant. Attached to the rear of this building and directly in front of the brick stack is the autoclave building. These two buildings house the ammonia process machinery. The stack is all that is seen of the process power house which furnishes steam for the autoclaves and the evaporating pans in the ammonium nitrate houses. The long low building in the background and to the right of this stack is the liquid air building, where nitrogen is made for the lime nitrogen ovens.

In the foreground of the right half of the view are the two ammonia gas holders, and directly behind these the six catalyzer buildings. Beyond these the low shed covering the nitric oxide cooling apparatus is

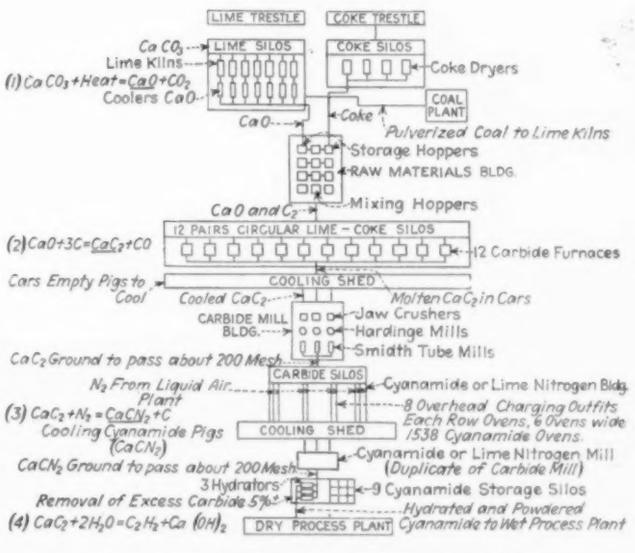


FIG. 5. FLOW SHEET OF DRY PROCESS

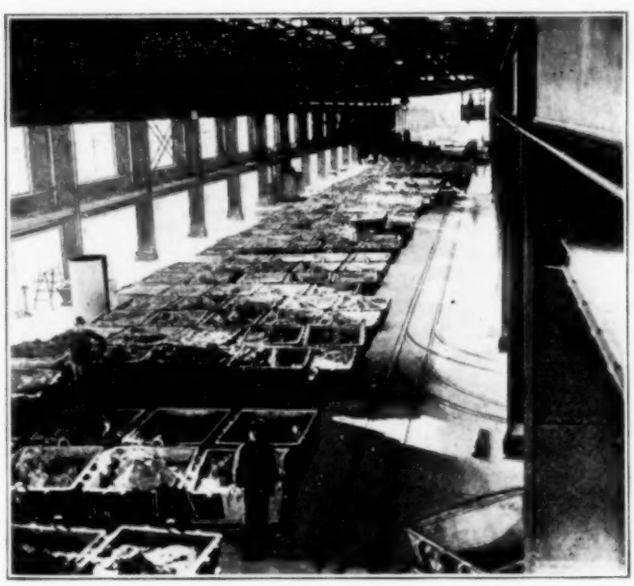


FIG. 4. CARBIDE COOLING SHED, LOOKING WEST

scarcely discernible as connecting them with the twelve sets of nitric acid towers standing in the high building beyond. On the extreme right is seen one of the five ammonium nitrate houses with five stacks showing, and a second one in the immediate rear. Three small substations for distributing current to the catalyzers lie between the catalyzer buildings, and the power substation for wet end appears to the right of the autoclave building.

THE PROCESS

Now it must be quite apparent that this mile of houses contains operations of some importance, and it is therefore well worth while to take a look within a few of the more important ones. Let us first take a walk down through the woods to the main power house on the river and see the largest steam turbine in the world, 60,000 kw., made by the Westinghouse Electric Co. It stands in the rear of Fig. 3 with two smaller turbo-exciters in front. If we were to take a walk about the place we could see where the 80-mile trans-

mission line comes in from the Alabama Power Co. and take a look up-river where the new dam is building; examine all the control panels in the switch room and point out the foundation for another turbine, 30,000 kw. As it is we return to the process plant through the bus tunnel, coming outdoors at the electric switchhouse.

Before entering the buildings again, examine the flow sheets (Figs. 5 and 6) and the subsequent views

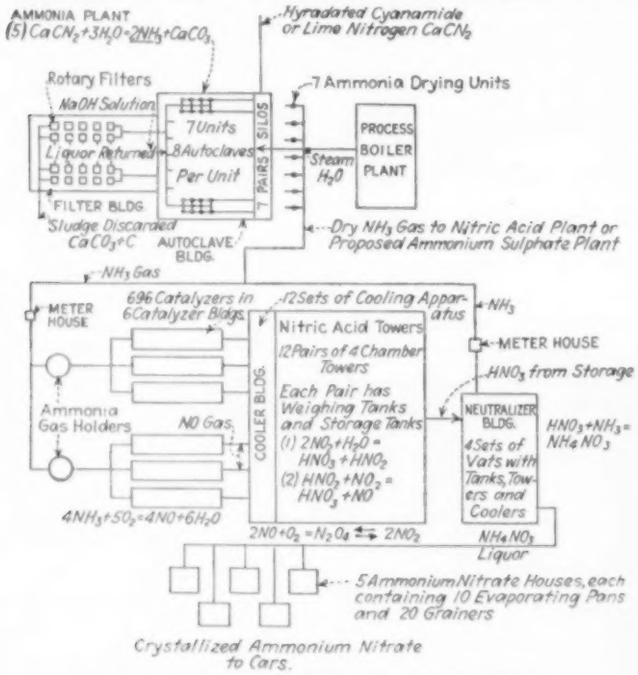


FIG. 6. FLOW SHEET OF WET PROCESS

will be the more easily oriented. Fig. 6 is just a continuation of Fig. 5, and the north to south flow is noted in comparing with the plan in Fig. 2. A sectional flow sheet shown in Fig. 9 gives a more detailed idea of some of the equipment.

Entering the carbide cooling shed (Fig. 4), we see the chill cars in which the molten carbide is taken from the electric furnaces on the right by electric locomotives and the chills subsequently distributed along the floor by the overhead crane seen in the rear. When these have cooled, the crane transports them singly to the concrete tipple pier at the entrance to the mill and shown directly beneath the crane on the left where the contents fall to the jaw crushers within.

Fig. 7 is a view of the mill looking northwest. The screw conveyor shown at the discharge end of the tube mill conveys the pulverized product to a common system where the output of all three mill units is carried in overhead screws to the lime nitrogen oven room.

Fig. 10 shows only a small portion of the oven room. The rail alongside the ovens carries the charging and discharging machines which straddle each double row. One of these is just visible in the rear of the left-hand row. The ovens are charged at the top by removing the sheet steel covers from the sand-seal on which they rest. The nitrogen is brought over from the liquid air plant in sheet steel conduits.

Fig. 11 is an interior view of the liquid air building, showing the largest installation of high-pressure air compressors in one plant. There are twenty-three in all, Sullivans, Norwalks and Ingersoll-Rands, of which five furnish service air for the shops and the acid lifts in the wet end, and eighteen operate on the liquid air production. The air columns are seen on the right and with a closer view in Fig. 12. There are thirty-six of

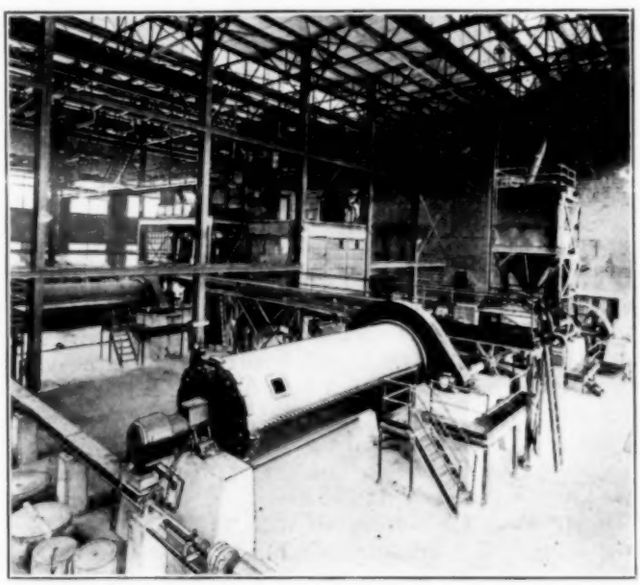


FIG. 7. CARBIDE MILL

these operating independently but with each compressor serving two units. The higher tanks shown at the end of the row are caustic towers employed for washing the air before it enters the compressors. Service cranes operate in both bays of this building.

FIG. 8. LOOKING EAST AT WET-END BUILDINGS

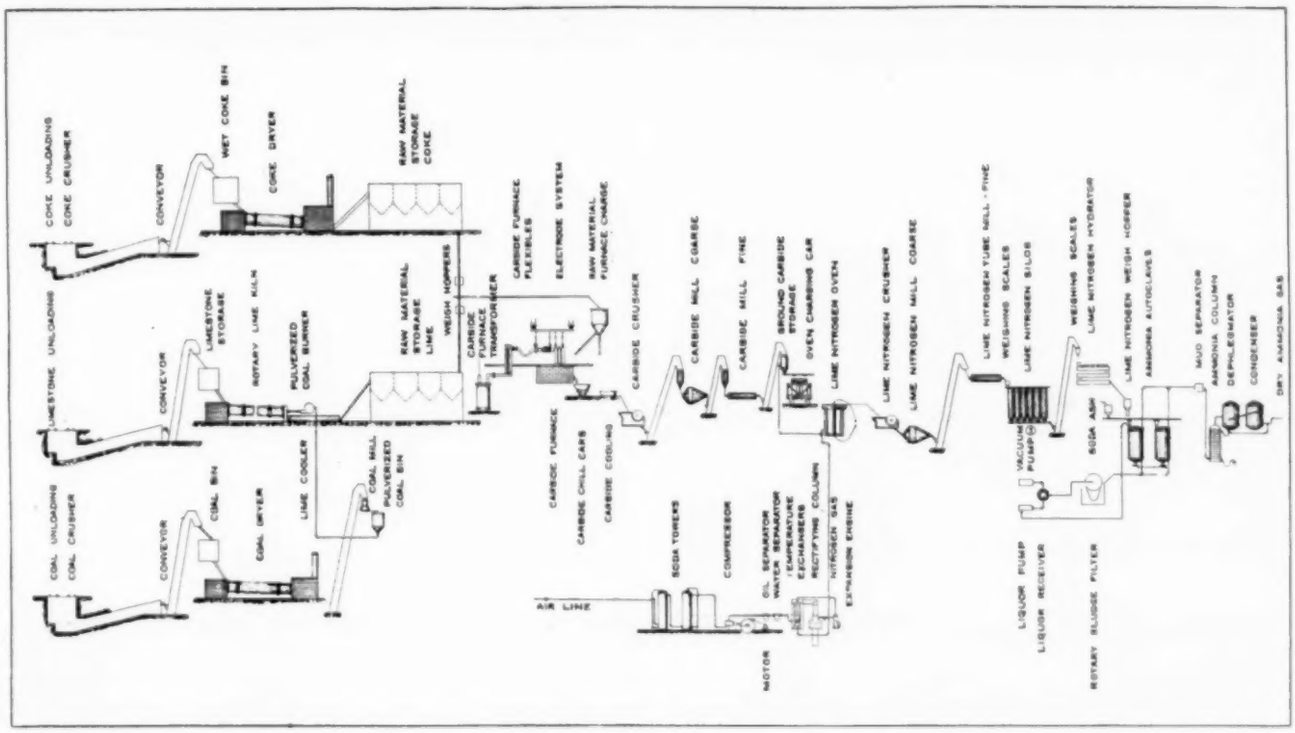


FIG. 9. SECTIONAL FLOW SHEET OF PLANT

Passing over the ammonia process, which is one of the secret operations, we come to the ammonia oxidation plant and see in Fig. 13 the interior of one of the six catalyzer buildings. The ammonia enters at the top of the aluminum boxes and passes downward into the brick flue as nitric oxide gas, when it is carried to the cooling, oxidation and absorption systems to produce nitric acid.

Fig. 14 is interior of one of the five ammonium nitrate houses. There are five rectangular evaporating pans on each side bay whence the concentrated liquor is drawn to the twenty grainers for crystallation. When the sirupy liquid is changed to sugar-size granules in these grainers the handwheel gates are opened, permitting the charge to flow onto the floor down the center, whence it is shoveled through the grizzly openings to a belt conveyor which carries it to storage or into the cars.

Rated capacities of apparatus in the plant are:

Coke Driers. There are four coke driers, three for operation, one for spare; capacity, 111 tons each for 16 hr.

Coal Driers. There are two coal driers, one for operation, one spare; capacity, 170 tons each for 16 hr., or at rate of about 10 tons per hr. per drier.

Coal Mills. There are four coal mills, three for operation, one spare; 3½ tons each per hr. for 16 hr.

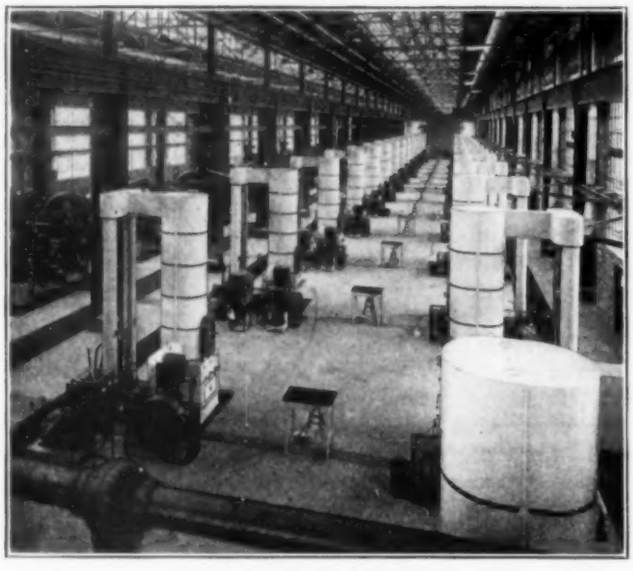
Limekilns. There are seven limekilns, five for operation, two spare; 100 tons per day each.

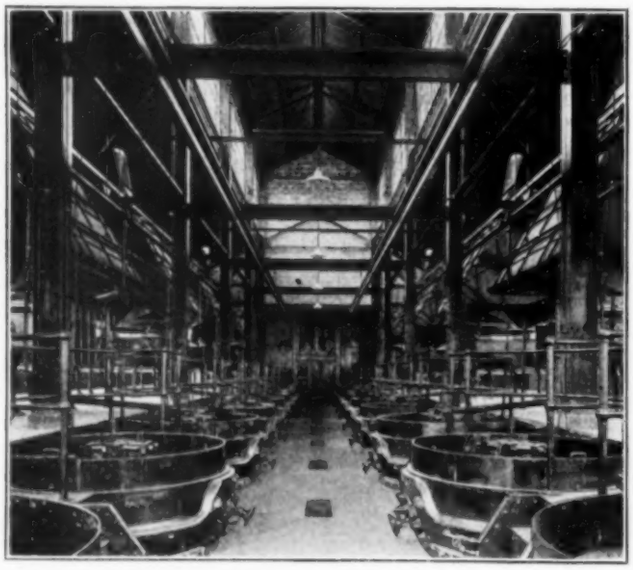
Furnaces. There are twelve furnaces, ten for operation, two spare, producing 48 tons of 80 per cent carbides each in 24 hr. There is 50 lb. of electrode consumed per ton of carbide. There is 12 lb. of CaC_2 produced per horsepower-day; 124 kilowatt-days required per ton of 80 per cent CaC_2, or 29.76 kilowatt-hours operating at an 84 to 87 per cent power factor.

Mill Units. There are three mill units, two per actual operation; 16 hr. per day; 240 tons each per day or 15 tons per hr. per unit.

Lime Nitrogen Ovens. There are 1,538 lime nitrogen ovens, 1,500 for actual operation and 38 spares. Each oven takes a charge of 1,600 lb. of carbide (1,570 actual) through a 60-hr. cycle or 1,200 tons of CaC_2 in

FIG. 8 (CONTINUED). LOOKING EAST AT WET-END BUILDINGS





FIGS. 10 TO 15

Top left, Fig. 10. Section of cyanamide oven building. Top right, Fig. 11. Air compressors, liquid air building. Middle left, Fig. 12. Liquid air columns. Middle right, Fig. 13. Catalyzer building, interior. Bottom left, Fig. 14. Ammonium nitrate house. Bottom right, Fig. 15. Section of construction camp.

60 hr., or 1,500 ovens every 2½ days, equals 510 ovens per day. This produces 600 tons of lime nitrogen daily.

Lime Nitrogen Mill. There are three mill units, two for operation, one spare; 16 hr. operation, 300 tons each.

Hydrating Building. There are three hydrators, two for operation, one spare; rated capacity 30 tons per hr. each.

Autoclave Building. There are seven autoclave units, six for operation, one spare; rated 100 tons per unit per day.

Filter Building. There are twenty filter wheels, fifteen for operation, five spare; rated capacity, 15 tons of sludge per filter in 24 hr. Total estimated tons of sludge, 720.

Nitric Acid Group. There are 696 catalyzers, one catalyzer producing 900 lb. 100 per cent HNO_3 for 24 hr.

FIG. 16. STREET IN PERMANENT VILLAGE

One nitric acid unit produces 22.5 tons of 100 per cent HNO_3 with 100 catalyzers in operation per 24 hr.

Neutralizer. There are four neutralizer units, each producing 100 tons of 100 per cent NH_4NO_3, three for operation, one spare.

Ammonium Nitrate Houses. Three hundred tons of ammonium nitrate total grained. Each house rates 60 tons per day. Each evaporating pan produces 8 tons per day. Forty pans for operation, ten spares. There are 100 grainers, eighty for operation, twenty spares. Each grainer handles four tons per day.

CONCLUSION

Neither space nor readers' patience will permit the penning of a eulogy on this work of our own engineers and craftsmen. It was made in the United States; the machinery, instruments and apparatus were turned out in our own factories; the special tile and chemical fittings testify to the achievements of our clay-working industries; the raw materials, the electrical equipment —but why continue, the story tells itself in pictures. Noble minds of many men have fabricated their souls' spirit into a being of metals and silicates which now lies sleeping in the Alabama sunshine while Government executives fiddle and politicians whittle. May the day soon come when it will be awakened to again sing a part in tune with the nation's industry and bring thereby all honor to these American engineers and workmen.

Prices Fixed on Sicilian Sulphur

By a decree of the Italian Ministry of Industry, Commerce and Labor, maximum selling prices on different grades of crude and refined Sicilian sulphur are established, to take effect retroactively from May 1. The decree is dated May 24 and appeared in the *Gazzetta Ufficiale* of May 29. The prices fixed by the decree for sulphur, refined or worked, apply to certain ports in Sicily which are taken as basing points. For instance, Catania, Licata, Porto Empedocle and Termini Imerese are named as the four Sicilian seaports for which the following base prices are given as the maximum per 100 kilos:

	Lire per 100 kilos.
Sulphur, advanced beyond crude state:	
Refined, in cakes	84.26
Refined, in rolls	87.26
Pure sublimed	108.62
Crude ground	77.46
Refined and ground:	
Content—	
From 60 to 65 per cent	96.90
From 65 to 70 per cent	98.35
From 70 to 75 per cent	99.98
Refined and fanned:	
Content—	
From 75 to 80 per cent	101.55
From 80 to 85 per cent	103.67
From 85 to 90 per cent	106.66

To each of these prices as tabulated is to be added the charge of 5 centimes per 100 kilos, or 0.5 lira per metric ton, as a contribution toward the support of the Sicilian Sulphur Consortium, of which all producers are obliged to be members. The given prices are f.o.b. vessels or loaded in cars at the station of any one of the four ports selected as basing points. To determine the maximum allowable prices for other points in Sicily, actual transportation charges from one of the basing points to the destinations in question may be added. Furthermore, in the case of refined sulphur in cakes, allowance may be made for loss in transit not exceeding 1 per cent.

The prices of crude grades of sulphur shipped to Italian destinations outside Sicily are to have added to them 120 per cent of transportation costs, the extra 20 per cent to cover cost of handling, with a permitted allowance for loss of weight in transit not to exceed 2 per cent. The prices of worked sulphur at points outside Sicily are to be calculated in the same way, that is, by adding 120 per cent of the freight charges to the base prices, but the maximum allowance for loss of weight in transit cannot be greater than 1 per cent.

On crushed sulphur ore the maximum prices per 100 kilos, f.o.b. cars at shipping point and exclusive of cost of bags, have been set by the same decree as follows:

	Lire per 100 Kilos
Sulphur content of ore:	
From 25 to 30 per cent	21.85
From 30 to 35 per cent	25.15
From 35 to 40 per cent	28.45
From 40 to 45 per cent	31.75
From 45 to 50 per cent	35.05

For the resale of worked sulphur and crushed ore an addition of 2 per cent is allowed on the fixed purchase price as it is prescribed by the decree or calculated on the basis of transportation charges in lots of 1 metric ton or more. On the resale of lots amounting to less than 1 metric ton an addition of 4 per cent is permitted in order to yield the dealer's profit.

The ministerial decree which establishes the prices set forth above does not set them for sulphur of fineness exceeding 90 per cent, washed sulphur for medicinal purposes, and flowers of sulphur, all of which are specifically exempted from the purview of this particular price-fixing measure.

Small-Scale Manufacture of Barium Chlorate

By Treadway B. Munroe

THERE has recently been published by the Ordnance Department, U.S.A., in three volumes, an excellent work entitled "Military Pyrotechnics," by Henry B. Faber, dean of the Pyrotechnic Schools of the Department, the third volume of which is devoted to "A study of the chemicals used in the manufacture of military pyrotechnics." In this volume there is given for each substance its history, occurrence in nature, method of manufacture, availabi'ity of supply, uses other than in pyrotechnics, physical properties, chemical properties, function in pyrotechnic pieces, qualitative analysis, quantitative analysis, specifications and discussion of specifications. Among these chemicals barium chlorate occupies an important place, and since examination shows that the only methods given in this treatise for the preparation of barium chlorate are through (1) the metathesis of barium chlorate with sodium chlorate, (2) the chlorination of barium carbonate, and, especially (3) "the electrolysis of barium chloride," which is said to be the method by which "the barium chlorate of commerce is invariably prepared," it seems proper to place on record an account of a recent emergency use of Wheeler's method[1] in the preparation of this substance.

During the early summer of 1917 the Navy Department laboratory at Indian Head, Md., was unable to obtain any bids for supplying barium chlorate for use in its green signal rockets and flares. Up to this time this material had been imported from Germany at a very reasonable price. Attempts were made to substitute compositions made from various copper salts and potassium chlorate, with sugar, flour and other combustible substances, but the brilliancy of the green light obtained with barium chlorate mixtures apparently could not be duplicated.

Aid to Navy Department

This condition was brought to our attention by the Government contractor who ordinarily supplied the requirements, with the statement that the shortage was acute, that he had been unable to obtain this material or enlist the interest of others in its manufacture, and that if we could arrange to make up to 500 lb. in the laboratory it would allow the department time to arrange for the development of a permanent source of supply. Under these conditions we promised to make it.

A survey of the materials immediately available having shown a sufficient supply of sodium chlorate, hydrofluosilicic acid and barium carbonate at hand, it was determined to proceed by Wheeler's method as shown in the following expressions:

$$2NaClO_3 + H_2SiF_6 \rightarrow 2HClO_3 + Na_2SiF_6$$

$$2HClO_3 + BaCO_3 \rightarrow Ba(ClO_3)_2 + H_2O + CO_2$$

All the substances employed were commercial. The determined amount of sodium chlorate was dissolved in the least quantity of hot water possible, this was then added to a known quantity of the hydrofluosilicic acid in a stoneware jar and allowed to stand until the sodium fluosilicate formed had settled; the chloric acid was then decanted to another stoneware jar, the sodium fluosilicate stirred up with hot water, allowed to settle and the weak acid decanted and added to that in the other jar. The chloric acid was then neutralized with barium carbonate, concentrated in galvanized washtubs and allowed to crystallize; the mother liquid was saved and then several portions batched together would be evaporated to dryness and this impure chlorate used in place of part of the sodium chlorate to prepare the chloric acid. The barium chlorate was crystallized a second time, dried on a fruit evaporator, ground to better than 80 mesh in a coffee burr mill and sacked. Something over 400 lb. was made and proved to be satisfactory. The work was discontinued when the Navy Department was able to interest other parties in manufacturing this material electrolytically.

Theoretically 1 part of sodium chlorate yields about $1\frac{1}{2}$ parts of barium chlorate; by this method we obtained a yield of but 1 to 1, the chief loss being due to the difficulty in separating the chloric acid from the sodium fluosilicate.

Difficulties Encountered—Interesting Sidelights

Attempts were made to use various stone and artificial filtering mediums with suction, but owing to the slimy character of the precipitate they invariably clogged. A centrifuge would probably have solved this difficulty, but time would not permit us to secure one. Another difficulty was that the chloric acid fumes given off from the hot solution killed the trees and other vegetation adjacent to the laboratory and attacked the eyes, throat and nose of the operator to such an extent that he was finally compelled to wear a British army gas mask nearly continuously during his work.

It is of interest to note that when this material was crystallizing from solution if the crystal formation was disturbed then both sound and green flashes of light were observed. This occurred in glass, galvanized iron and wooden containers. Reference was found in the literature to the fact that sound is given off through agitation of the crystals, but we have at no place noted it recorded that light is given off also.

It is also of interest that the production of barium salts in this country, other than the natural barium compounds, was so new at that time that this small production was taken into account by the Geological Survey in its 1917 report.

Some of the crystal groups obtained in the course of this work were quite attractive. One of them, in fact, was presented to the National Museum and deemed by its curator worthy of a place in its exhibits.

[1] "On the Fluosilicic and Chloric Acids," by J. L. Wheeler. *Quart. J. Sci.*, vol. 4, pp. 287-289; 1818.

Proposed Law to Permit Exportation of Pulpwood From Burned-Over Lands in Canada

A bill was introduced in the Provincial Legislature of Ontario on May 20, 1920, by the Minister of Lands and Forests, in which authority is provided for the exportation of pulpwood from areas which have been burned over by forest fires.

The object of the bill, as explained by the Minister, is to get the pulpwood cleaned off in these districts quickly in order to prevent a recurrence of forest fires. The districts to be cleaned up in this manner are not large, though the bill provides that the government shall decide what areas are included in the measure.

Early Commercial Electrolytic Cells*

Reminiscences of the Pioneer Chlorine Cell Work Done at Rumford Falls, Maine, and Berlin, New Hampshire—Graphite Electrodes Introduced—Porous Diaphragm Cell Developed

By CHARLES B. BARTON

THE paths of the early workers on electrolytic cells were not strewn with roses. They were very rocky. I speak from experience, for I think I have been continuously in the business longer than any other man in this country. In September, 1894, I went to work for the old Electro-Chemical Co. of Rumford Falls, Me., as a laborer; twenty months later I was made superintendent of the plant, and have held that position there, and subsequently in Berlin for the Brown Co. This makes twenty-six years of experience.

The original cells in Rumford Falls were the old belljars, with an asbestos diaphragm, approximately horizontal. The anodes were of retort carbon and were cast in lead, a projecting portion coming through the top of the belljar, to which was connected the positive wire. The cells were supposed to take about 100 amp. each and were run in parallel in the iron cathode tanks, the tanks being connected in series. The diaphragms of these cells had to be changed very often, the units were too small, and when I entered the employ of the company in 1894 it had discarded this type and was changing the type of cell.

These second cells were square boxes about 24 x 24 x 24 in., the top and upper third of the outside being made of slate with a slate cover, a wooden leg on each corner and a wooden bottom. Around the open part asbestos paper was wound for a diaphragm and outside of this wire netting, the netting being turned on the bottom of the cell so as to give electrical contact with the bottom of the iron tank, which held the cathode bath. The anodes were of gas carbon, with the ends cast in lead and space between the central anode proper, and the asbestos diaphragm was filled with lumps of broken retort carbon, the object being two-fold: To hold the diaphragm against the cathode and to bring the active anode surface closer to the cathode surface. About 500 of this type cells were discarded and another type later installed.

The third type of cell was a slate box with gas retort carbon anodes and no packing between the anode and the diaphragms. They were of various sizes, a large number about 36 in. in length x 6 in. wide and about 18 in. deep. These cells are very similar in construction to cells in commercial operation today. They were, however, soon discarded in favor of another type installed.

The fourth type was a distinct departure from the previous types. It was a large unit and was contained in a cathode tank, 9 ft. long, 5 ft. wide and 18 in. deep. A wooden frame of 4 x 6 in. lumber was laid in the bottom of the tank, on this frame a grid of iron made of $\frac{3}{8}$ x $1\frac{1}{2}$ in. iron stock was laid and part of the irons were extended and bolted to the tank to make contact with it. These irons were inclined to the horizontal so there was a pitch of 2 in. to the foot. On top of these irons a wire netting was placed to act as the cathode proper, and on top of this cathode a diaphragm of asbestos paper was laid. The side walls of the cells were made of red brick and the diaphragm was cemented in with quick-hardening cement. The covers were slate and the anodes were platinum wire. About fifty of these were operated during the spring and summer of 1898. The design was good and with the substitution of perforated metal plate for the iron grid and concrete side walls for the brick and wood the same cells are running today and are running efficiently.

Transfer of the Electro-Chemical Co.

The plant of the Electro-Chemical Co. of Rumford Falls closed in the fall of 1898 and part of the plant and operating personnel were transferred to Berlin, N. H., to make chlorine for bleaching the pulp of the Burgess Sulphite Fibre Co. T. P. Burgess, the manager of this plant, believed in the future of electrolytic chlorine and he believed that experience was the most valuable asset he could buy. He bought the experience of the Rumford Falls plant and he paid a very low price for it. The stockholders of the Electro-Chemical Co. shouldered their loss. The stockholders of American electrolytic chlorine and caustic soda corporations owe to stockholders of the old Electro-Chemical Co. at least a debt of gratitude. Let us analyze the reasons why the different cells developed at the Rumford Falls plant were not a success commercially. The first cells of the old belljar type failed because they were too small a unit, the diaphragm broke too often, and they were connected in parallel in the cathode tanks. The second cells failed because of the wooden construction of the body, the fact that the anode compartment was filled with broken pieces of carbon so as to give very poor circulation, and because of the method of making electrical contact to the anodes, which, you will recall, was by casting the upper ends in lead. The lead soon became oxidized at the points of contact, and this caused a rising voltage and uneven distribution of current in the tanks, for these cells had the fault of the previous ones, that they were connected in parallel.

The third type of cells failed because the same method of making electrical contact with the anode, casting in lead, was used, because the cells were connected in parallel, because too small a chlorine chamber was left in the cell and because the material of which they were composed, slate, was not the proper material of which to make cell bodies.

The final type of cell developed at Rumford Falls was a commercial failure there because the stockholders did not care to sink any more money in the plant. It was a success in Berlin.

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920

I think it is proper at this time to state that E. A. LeSueur had no active part in the management of the Rumford Falls Electro-Chemical Co. until the original development funds were about all spent. After the original management had demonstrated it could not run the plant at a profit he was made manager, but there was so little money available for experiments and development that the plant could not be developed to a commercial success. The offer from the Burgess Sulphite Fibre Co. to take over the plant came while the plant in Rumford was still in operation and was accepted as an easy way out of an exceedingly uncomfortable financial condition.

Trouble With Carbon Dioxide

It is now time to mention a few of the difficulties of operation encountered in the infant industry. The draft for moving the chlorine was originally obtained by introducing a pipe into the draft tube of the water wheels. It was later produced by steam siphon. The gas pipes to all the first cells were of lead and of small diameter, so that they were always clogging up. The brine was fed to the cells by means of a dipper and a funnel through a hole in the top of the cells, and when acidulated brine was introduced to a cell whose anode compartment was full of sodium hypochlorite the foam immediately clogged the gas pipes and imparted a green tint to the atmosphere. In fact, the atmosphere of the cell houses was usually slightly green and all men who entered the cell houses wore muzzles. A cell whose anode compartment is contaminated with alkali always runs at a low current efficiency. The oxygen liberated at the anode immediately attacked the amorphous carbon and formed CO_2 with which the chlorine was contaminated. The lime spread in the bleach chambers absorbed the CO_2 and this lowered the test of the bleach so that it was not always salable, in competition with English bleach. It was observed, however, that the CO_2 always combined with the top lime and formed a hard crust. It was necessary to skim off this top crust in order to produce merchantable bleach.

This difficulty finally led to experiments with platinum anodes, which seemed to promise elimination of our troubles. It was necessary because of financial reasons to use the smallest amount of platinum possible. Mr. LeSueur produced a platinum anode which was based on the idea of the electric light bulb. Sixteen pieces of platinum wire about 4 in. long were sealed in a glass tube in the same manner as was formerly usual in making light bulbs. About ½ in. of wire was left inside the tubes, and the outside wires, which were flattened, were spread like the spokes of a wheel at right angles to the tube. Electrical contact to the inside wires was made by a drop of mercury. It was necessary to have a horizontal diaphragm to use this anode, and they were used in the last type of cell installed in Rumford Falls.

The money for this last installation was very meager. The directors wanted a profit or they wanted to close down the plant, and not enough platinum anodes were allotted to each cell to carry the load. The result was that many of them cracked. This threw the load on the remainder, with the result that the cells ran at very high voltages, from 5.5 to 7.5 or 8 per cell, at 1,200 amp., with about 30 sq.ft. of diaphragm per cell. This produced a very peculiar and puzzling result. The temperature rise was so great that sodium chlorate was formed in large amounts; the caustic liquor going to the kettles contained only about 2 per cent NaCl, but the finished product would contain about 10 per cent. When the reason was discovered all caustic liquor was treated with potassium chloride, and we were obliged to go into the manufacture of chlorate of potash. It was at the time of the Spanish-American war and chlorate of potash, being contraband, shot up in price, so that it really was a blessing in disguise, and allowed us to weather the gale for a little longer. However, after the offer from the Burgess Sulphite Fibre Co., we soon shut down and thus closed the first commercial American plant of porous diaphragm cells for the production of chlorine and caustic soda.

McDonald and Mercer were foremen of the cell houses in Rumford Falls. H. K. Moore had his first experience with cells in the employ of the Rumford Falls plant. The Nelson cell was born of experience with the McDonald cell, which was a copy of the third type of LeSueur cell. I should like to read some claims of the LeSueur cell patents granted in 1891, now lapsed.

> 2. An electrolytic cell comprising a bell of earthenware, a positive electrode therein, a diaphragm covering the mouth of said bell, a negative electrode, and a tank in which said bell is placed, the level of the liquid within the bell being higher than that of the liquid outside the bell, whereby the diaphragm is prevented from bulging, substantially as set forth.
>
> 3. An electrolytic cell comprising a combination, with a tank to contain liquid, of a bell in said tank, positive and negative electrode, and a flexible diaphragm between said electrodes and covering the bottom of said bell, said diaphragm being adapted to maintain the liquid of the positive electrode side of the said diaphragm on a higher level than that of the liquid of the negative side of the diaphragm, whereby the diaphragm is kept from approaching the positive electrode, substantially as set forth.

In the LeSueur electrolytic patents the principle of having on the anode side of the diaphragm a greater hydrostatic head than is carried on the cathode side is first mentioned. Unless I am greatly mistaken, these patents were the foundation of all electrolytic porous diaphragm cells, and credit should be given E. A. LeSueur as being the real founder of the industry.

Early Work at Berlin

When we moved to Berlin, N. H., in October, 1898, it was with the purpose of making bleach liquor for bleaching the pulp, and letting the caustic run to waste. The plant was a success from the start, though handicapped in various ways. Seventy-two cells were installed to run at about 1,000 amp. The writer should have known better from past experience, for he made a mistake in starting the original plant in using the exhaust steam from the engine that furnished the auxiliary power to heat the water that was run in the cathode compartment to flush out the cathode liquor. This made the cathode liquor so active that it diffused into the anode compartment to such an extent that it seriously affected the efficiency of the plant. This mistake, was, however, soon rectified.

The power for the operation of the cells in Berlin was bought under a peculiar arrangement. The power from four water wheels, a maximum of about 1,000 hp., was contracted for at a low figure, when there was water enough in the river to run these wheels, the six other wheels in the same power house having prior right to the water and running the sawmill. The result was that the power was very uneven and in the winter of 1899-1900 it was necessary to shut down.

The writer moved to the sulphite mill and set up some

experimental cells in the digester building. There we ran experiments for several months, mostly on cells of the Moore type, and with the new Acheson graphite, which had just then come on the market. In plotting the variables, and trying to find why some cells ran better than others, I found that by manipulating the flow through the diaphragm in proportion to the amperes going through the cells, using saturated brine, I could get any results I desired within certain limits. If we wanted to get 97 or 98 per cent current efficiency we simply increased the flow to the point necessary. This would decompose about 50 per cent of the salt in the brine fed to the cell. If we wanted to decompose about 60 per cent of the salt we reduced the flow to the point on the curves that would give this figure, and would get about 90-91 per cent current efficiency.

Acheson Graphite Electrodes

We immediately designed a cell and installed 160 of them, the original Moore cells, the first cells run commercially with unsubmerged cathodes. There were mistakes made in the construction. The frames were made of slate put together with wood screws. They were installed in a single row, on about 8 in. centers. The graphite was not impregnated, the brine was not purified. The gas outlets were 1 in. glass tubes. The gas space in the cells was too small and they vomited chlorine continuously. We lived, I don't know how, with them nine months, and then threw them all out the back windows, and called it good riddance. The principle was all right, but we did not work it out to its logical conclusion. I had been steeped in chlorine for nine months and cared nothing about principles or conclusions. Now, however, we had Acheson graphite. The graphite from the Moore cells was used in the LeSueur cells and we soon began to get wonderful results for that time. The voltage drop on individual cells was 4 to 5 volts, instead of 5.5 to 6.5 with a platinum anode. The production jumped, while the power required per ton of bleach was lowered from 100-125 hp. to 80-90 and, of course, in later years to 60-70. The real feature of the electrolytic cell dawned with Acheson graphite anodes. The original plant in Berlin had grown from seventy-two cells, with a production of 3 to 6 tons of bleach per day, to a plant with about 800 cells and a maximum production of 80 to 90 tons 35 per cent bleach. The water wheels that formerly furnished power for the sawmill and caused the shutting down of the bleach plant wheels are now furnishing power for the cells as well as all the other wheels in the next lower power house, and half the wheels on the one below that. We have installed 160 of the latest type of Allen-Moore cells, which resemble the original ones only in principle. H. I. Allen, with H. K. Moore, developed the cell from the point where we left it.

About the same time that the LeSueur cells were started in Berlin, N. H., in 1898, an installation of Carmichael cells was started at the Westbrook, Me., plant of the S. D. Warren Paper Co. These cells used platinum wire anodes and the gravity principle of separation. They were not a commercial success.

The history of the development of the diaphragm electrolytic cell emphasizes the well-known point that new processes are best developed by a well-organized corporation, engaged primarily in some other business that can bear the financial burden of experimental failures and keep on until success crowns its efforts.

What Constitutes Unfair Trade Practice?

THE recent citation by the Federal Trade Commission of firms operating in restraint of trade may have caused the question to arise in the mind of the reader as to just what constitutes unfair trade practice. As a matter of general information the following list of unfair methods, taken from a recent address of a member of the Federal Trade Commission, William B. Colver, is given:

Misbranding of articles as regards the materials or ingredients of which they are composed, their quality or their origin or source.

Adulteration of various products, misrepresenting them as pure or selling them under such names and circumstances that the purchaser would be misled into believing them to be pure.

Bribery of buyers or other employees of customers with money, valuable presents, etc., to secure new customers or induce continuation of patronage. The payment of specified percentages of the purchase price of commodities to employees of customers who practically control the purchases through their recommendations has been and still is deplorably prevalent in some industries. The total amount of these commissions runs into enormous sums. If the practice can be prevented it will save much money to the sellers of the goods, making price reductions possible or rendering further increases in prices unnecessary, and tend to better business morals. A variation of this practice is found in bribing an employee of a customer to introduce foreign substances into the product of a competitor, spoiling its usefulness and thus procuring the business of the concern. The commission has suggested to Congress that a Federal criminal law against commercial bribery should be passed, and this suggestion has been vigorously approved by many great associations of business men.

Unfair Methods Against Competitors

The payment of bonuses by manufacturers to the salesmen of jobbers and retailers, with or without the knowledge of their employers, to procure their special services to push the goods of the manufacturer has likewise been condemned.

Procuring the business or trade secrets of competitors by espionage on their plants, by bribing their employees or by similar means.

Procuring breach of competitors' contracts for the sale of commodities by misrepresentation or by other means.

Enticing away of valuable employees of competitors in such numbers as to disorganize, hamper or embarass them in business.

Making of false or disparaging statements respecting competitor's products, his business, financial credit, etc.

False or misleading advertising. There are obviously many varieties of this practice. A few of the statements condemned have been those respecting prices at which goods are sold, methods employed in the advertiser's business which if true would give it advantages over competitors in the matter of prices; misrepresentation that goods are sold at cost; false claims to Government indorsements of products, and advertising special cut-price sales at which goods are sold at the usual or ordinary prices.

Widespread threats to the trade of suits of patent

infringement for selling or using alleged infringing products of competitors, such threats not being made in good faith but for the purpose of intimidating the trade. False claims to patents or misrepresenting the scope of patents. Statements of this character have been at times sufficiently broad to give claimants a monopoly of an industry. In one instance a manufacturer procured a patent on a variation of a well-known and long used process of manufacturing a product and thereafter claimed to have a monopoly of the product, threatening all competing manufacturers and the trade with suits for infringement.

Tampering with and misadjusting the machines sold by competitors for the purpose of discrediting them with purchasers.

Trade boycotts or combinations of traders to prevent certain wholesale or retail dealers or certain classes of such dealers from procuring goods through the usual channels.

Passing off of the products of one manufacturer for those of another by imitation of product, dress of goods, or by simulation of advertising, or of corporate or trade names.

Misrepresenting the materials of which competitors' products are composed, and the financial standing of competitors, preventing competitors from procuring advertising space in newspapers or periodicals by misrepresentation respecting their financial standing or other misrepresentation calculated to prejudice the advertising medium against them.

Misrepresentation in the sale of the stock of corporations.

Sale of rebuilt articles of various descriptions—for example, rebuilt automobile tires and of old motion picture films slightly changed and renamed—as and for new products.

Harassing competitors by fake requests for estimates on bills of goods, for catalogs, etc.

Giving away of goods in large quantities to hamper and embarass small competitors.

Sales of goods at or below cost to accomplish the same result.

Sales of goods at or below cost as "leaders," coupled with statements misleading the public into the belief that they were sold at a profit by reason of the sellers' superior facilities for manufacturing, purchasing, etc.

Bidding up the prices of raw materials to a point where the business is unprofitable for the purpose of driving out financially weaker competitors.

Unfair Methods in Dealing with Customers

Loaning, selling at cost, or leasing to dealers at nominal considerations, storage and merchandising outfits such as pumps and tanks for gasoline and coffee urns for coffee, on the condition that they be used only in the distribution of the products of the manufacturer. The effect of the widespread use of this method is to render it very difficult, if not impossible, for competitors coming into a field to find purchasers among the trade since the equipment of dealers must be used only in the distribution of products of particular manufacturers. To illustrate the consequences of the practice, in one instance a very large corporation which had been engaged in foreign trade sought, after the opening of the war, to go into domestic business, and found itself practically unable to sell because of outstanding equipment contracts. The expenditure of hundreds of thousands of dollars was required in purchasing the business of concerns with outstanding leases or contracts for the use of equipment before any substantial business could be done. Only the great financial strength of the corporation enabled it to enter the business at all. Of course, in the end the public paid the bill. Such loans or leases of equipment have been prohibited in several industries.

There is the use by monopolistic concerns of concealed subsidiaries for the carrying on of their business, such concerns being held out as not connected with the controlling company.

Intentional appropriation or converting to one's own use of raw materials of competitors by diverting shipments, etc.

Giving and offering to give premiums of unequal value, the particular premium received to be determined by lot or chance, thus in effect setting up a lottery.

Any and all schemes for compe'ling wholesalers and retailers to maintain resale prices on products fixed by the manufacturers. The commission is seeking with the sportsmanlike aid of the Beech-Nut people, to have this question settled by the United States Supreme Court in a test case. Meanwhile the commission has urged upon Congress a law that will recognize and protect with proper safeguards the good-will property right which a maker of identified goods may have after he has parted title to the goods themselves.

Combinations of competitors to enhance prices, maintain prices, bring about substantial uniformity in prices, or to divide territory or allot customers.

In addition to the practices already enumerated there have been cases where a number of practices associated together were condemned because of their combined effect unduly to restrict competitive opportunity and where it could not be said probably that any single practice standing alone would have been condemned. A clear idea of these can probably only be had by reading the findings and orders of the commission in the particular cases.

Attitude of the Supreme Court

Though the commission was organized in the spring of 1915, only one decision of the Supreme Court of the United States has thus far been had interpreting the provisions of Section 5 of the commission's organic act. This decision actually determined only a point the commission had not pleaded that the particular practice had a dangerous tendency actually to restrict competition. It appears from the opinion, however, that the court is inclined to establish two classes of practices as being in violation of the act: First, those practices which have heretofore been regarded as opposed to good morals because characterized by deception, bad faith, fraud or oppression, and second, practices regarded as against public policy because of their dangerous tendency unduly to hinder competition or create monopoly. Apparently, if a practice have this dangerous tendency it will be regarded by the court as in violation of the act, even though not heretofore declared to be an unfair method of competition.

By far the greater part of the practices thus far condemned by the commission fall within the first class described by the court. Some of them depend for their unfairness, however, on their tendency unduly to hinder competition. Whether such a practice has this tendency depends on the proof in the particular case.

Elements of Design of a Copper Refinery

Certain Features of a Refinery Must Be Settled First, Such as Location, Capacity, Current Density, Tank Dimensions, General Wiring and Switchboard Diagrams, Size of Anode and Cathode Furnaces, Purification System and Type of Silver Refinery

BY LAWRENCE ADDICKS

UP TO the present time electrolytic refining has been conducted almost exclusively in the United States, about 80 per cent of the world's production being treated here. This has been due to several factors. The North American continent has produced the great bulk of the world's output of copper, metallurgical operations have been developed on a larger scale in America than elsewhere and the local copper production has been largely consolidated into a few large groups each capable of supporting one or more large refineries.

LOCATION

Since the war the nations of Europe have developed a new desire to control key industries complete within their own borders, home or colonial, and new tariffs, trade routes, etc., are likely to cause the building of various new refineries. In general the factors associated with the movement of copper from mine to market, rather than those directly connected with refining, such as cost of power, are likely to control the location of a plant. Unless a plant is built to refine a large tonnage from a single group of mines, care must be taken when determining upon its location to consider breadth of both copper supply and market. The result has been to group a number of the American refineries around the port of New York because at that point rail shipments from Western smelters and ocean arrivals from South America conveniently join steamship deliveries to Europe and railroads to New England mills.

One of the advantages of having a refinery close to an Atlantic port is that orders can be filled promptly in the particular shape specified, enabling the European customer to play close to a fluctuating market, which at times would result in a preferential sale. Another objection to locating a refinery at a far distant mine is that a long time elapses between the production of a wirebar and its actual rolling, so that there is no prompt independent check upon the quality of product the plant is turning out. Aside from these considerations, the availability of a suitable coal for furnace work and the existence of a good boiler water together with ample water for condensing must be looked into.

CAPACITY

In the same way external considerations may justify the operation of a plant of a capacity far below the economic size, but the latter is a point of universal interest. In these days of economic disturbances it is very hard to state anything in terms of absolute cost, but a relative diagram may be made, showing with reasonable reliability the relation between plant capacity and operating cost. This has been attempted on a percentage basis in Fig. 1, where it is shown that not much is to be gained, in so far as cost is concerned, by making a plant of larger capacity than 200,000,000 lb. of copper per year. Even this figure, however, is beyond the reach of any but the largest mining groups, so that there will always be a large custom refining business.

TANK HOUSE

Having decided upon the size of plant to be constructed, the next problem is the choice of the current density. This question has already been discussed at length in a previous article (CHEM. & MET. ENG., March 15, 1917), and in turn depends upon several primary factors such as cost of power, silver values, etc. It has also to be remembered that the plant will earn more on its investment when operated at a little higher density than that giving the lowest operating cost. For example, if a certain plant could treat its most economical tonnage of 100,000 tons a year for $20 while by

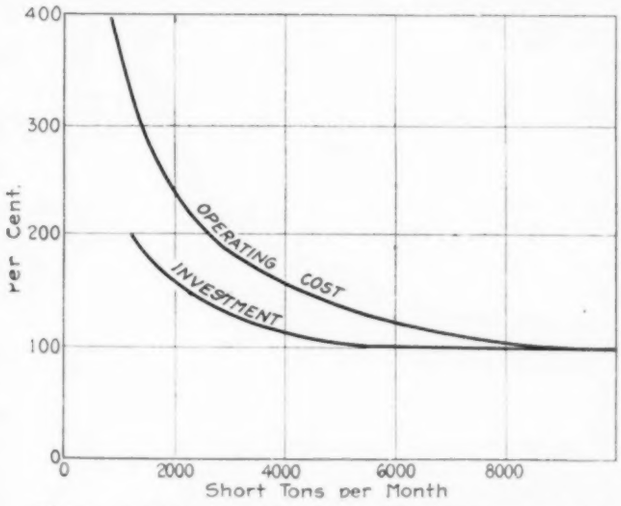


FIG. 1. VARIATION OF COST WITH SIZE OF PLANT

raising the density proportionally it could treat 110,000 tons at $20.30, 120,000 tons at $21, with very little additional capital expenditure, and the refining toll was $25 a ton, then the earnings on 100,000 tons would be $500,000 a year, and on 110,000 tons $517,000, but on 120,000 tons only $480,000. On the other hand, it is generally wise to leave this margin for the growth of the business.

The density having been settled on, tank dimensions have next to be considered. In the earlier plants electrodes about 2 x 3 ft., twenty pairs to the tank, were used with densities around 15 amp. per sq.ft. This gave 3,600 amp. on a circuit, which was in those days a heavy amperage to rectify on a single commutator. Today thirty pairs of electrodes are used without material lowering of the current efficiency and in one plant electrodes 4 ft. square are in successful use, although 3 ft. square is a more popular size where soluble anodes are

employed. With thirty pairs of 3-ft. electrodes and the average density of 20 amp. per sq.ft. the current on a circuit becomes 10,800 amp., still well within the limits of the modern commutator. At an overall current and time efficiency of 85 per cent this current will produce 17,258 lb. of copper per tank per month, or 575 lb. per pair of electrodes.

The spacing center to center of anodes will lie between 4 and 4½ in., depending upon the purity of the bullion treated and the age of electrodes adopted. In general the column of liquor between anode and cathode should be about 1¼ in. across. General practice as to the age ratios of electrodes is indicated in Fig. 2. At the lower densities cathodes and anodes are of identical age, while as the density rises increasing numbers of sets of cathodes are drawn during the life of one set of anodes. The weight of the anode can be obtained by multiplying the expected output per tank-day per pair of electrodes by the days' life determined upon and adding 15 per cent to this figure to allow for anode scrap. From the area and weight (allowing something for porosity) the thickness may be calculated, and this plus 2½ in. will give the anode spacing.

Having settled upon the output per tank-day, the total number of tanks required is at once obtained, and the next question to be considered is the number of independent circuits required. In general the voltage per tank will be somewhere between 0.30 and 0.45 volt. This figure depends upon many factors, the chief being the current density. An average value in practice would be 0.35 volt. To this must be added a sufficient allowance for liberator and stripper tanks. The former require about 2.2 volts when on normal work and 2.5 volts when used for complete removal of copper. Ordinary work would call for 2 per cent of the former and none of the latter, but this depends upon the analysis of the anodes to be handled. Stripper tanks are operated on a somewhat wider spacing than regular tanks, and this means fewer pairs of electrodes, higher current density and higher voltage—say 0.50 volt as compared with 0.35. If we take 80 per cent of the number of electrodes per tank, 24-hr. sheets, allow another 20 per cent for loops and bad production and 10-day cathodes, not forgetting that one stripper blank yields two starting sheets, each regular tank will demand the equivalent of three sheets a day, while each stripper tank will produce thirty-eight sheets a day.

Power House

The general power problem will be reviewed in the last article of this series.[1] To this may be added, however, some notes on electrolytic switchboards.

Heavy direct currents are satisfactorily handled by multiblade knife switches with a duty of 50 amp. per sq.in. of sliding contact. Circuits are neither opened nor closed under load, but a circuit breaker with a no voltage release should be placed on each circuit, not as a protection to the generator, the armature resistance of which is too low to "short circuit," but to protect men and apparatus in the tank house. It is not uncommon to have an open circuit due to the crane drawing cathodes by mistake from a tank which has not been cut and heavy arcing may result. A bar or tool laid across lines where any considerable effective voltage is present is promptly "burned out." An automatic engine stop should also be provided in the case of reciprocating engines, as with a sudden release of load due to the opening of the circuit breaker there is always a chance that the governor will act sluggishly, as the steady full load day after day gives it but little exercise.

Recording and integrating instruments are not of great value on the electrolytic switchboard, beyond giving a check on the employees, as hourly readings of the indicating instruments are ample for all records.

Several precautions are necessary in setting instruments on the board.[2] With voltmeters there is little trouble, though the same precautions must be taken with regard to the effect of stray field as stated below for ammeters. The very heavy currents met with in electrolytic work accentuate some causes of error which are ordinarily negligible in switchboard ammeters, and if a limiting error of 1 per cent is to be attained distribution of the current in the shunt, thermo-electric effects, switchboard temperature, magnetic effect of stray field on the instrument and possible dynamo action of the leads must be accounted for. Error of 1 per cent may be taken as the limit of accuracy of the best types of switchboard ammeters for heavy direct current.

Care should be taken to place both shunt and instrument in suitable positions when designing the switchboard. In the first place, the shunt should be obtained from the maker with short bars inserted in the slots

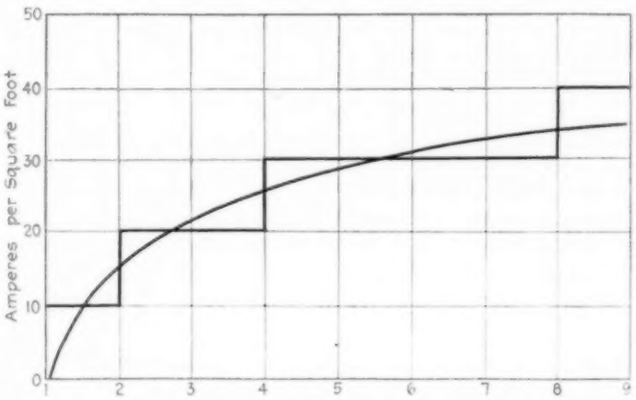


FIG. 2. CROPS OF CATHODES DURING LIFE OF ANODE

usually provided in the shunt terminals, these bars in turn to be bolted to the busbar carrying the current to be measured. In this way the shunt is calibrated with the same distribution of current through the various leaves, as will be the case in after use. It is practically impossible to disconnect a high-capacity shunt down to the slotted terminals and put it back in place again without altering the calibration more or less, due to change in the distribution of the contact resistance between main bar and shunt terminals, and consequent slight change in the amount of current carried by the different leaves of alloy. This, in turn, slightly affects the ratio between drop of potential between binding posts and total current carried. These changes in resistance are very small, but the total resistance of a good 5,000-amp. shunt is but about 0.00001 ohm. There is no way to detect the error introduced in this way except by calibration in place.

Unequal heating of the two shunt terminals will introduce a constant error from the thermo-electric junctions formed where the alloy leaves are soldered on to the copper blocks. This may easily amount to 1 per cent of the full-scale reading, may be either positive or nega-

[1] Publication to follow shortly.

[2] Addicks, *Trans.* Am. Electrochem. Soc., vol. 9, p. 239.

tive, and will show as a zero error on shutting down the circuit which will gradually disappear as the shunt cools off. Sometimes compensating devices are applied to avoid thermo-electric errors, but if the shunt is so placed in the busbar that the facilities for conducting away heat are approximately equal on both sides, there will be no appreciable error, and such devices should be unnecessary. The alloy leaves of a shunt would be red hot at full load were it not for the heat-dissipating qualities of the large copper terminals. There should be practically equal radiating surfaces of bus bar for 3 or 4 ft. each side of the shunt. If placed close to a switch on one side, there is sure to be a thermo-electric error in the shunt, as high capacity switches frequently run hot. The best plan is not to attempt to place the shunt back of the switchboard at all.

Danger of Overheating Shunt

The temperature at which a shunt runs will depend upon how heavily it is loaded and the opportunity afforded to dissipate the heat generated. The temperature indicated by a thermometer and well placed upon one of the terminal blocks should not be allowed to exceed 200 deg. F., owing to the danger of starting the solder and consequent failure. The temperature coefficient of the alloy used in the resistance leaves is generally so low that no correction to the instrument reading need be applied for the heating of the shunt.

A sensitive millivoltmeter is used to measure the drop. The condition for maximum sensitiveness would require that all of the resistance of the instrument be in the armature of the d'Arsonval type so generally used. And in order that a given resistance may afford as many ampere turns as possible without making too heavy a bobbin, the material must be one low in specific resistance, such as copper. The use of copper means a high temperature coefficient, and in order to keep within 1 per cent on large switchboard ammeters it is always necessary to correct for instrument temperatures. The largest size of instrument—independent of capacity, as change of size for current rating is made in shunt and not in instrument—has a temperature coefficient corresponding to that of pure copper, or about 0.2 per cent per deg. F. The smaller types are lower in temperature coefficient, as the lighter movement gives the instrument designer more leeway. In high-resistance instruments, such as voltmeters, there is a series coil, made of low temperature coefficient alloy, which forms so large a proportion of the total instrument resistance that the coefficient of the whole is negligible.

Stray Field

One of the most important sources of error is the magnetic effect of stray field in the immediate vicinity of a bar carrying several thousand amperes. Instruments should never be placed within 2 ft. of such bars. The iron shield usually provided is not only likely to be faulty as a filter for lines of force of such density, but consequent poles are formed in the case itself.

The magnet of an unscreened Weston portable instrument may be permanently altered by placing the meter too close to such a bar, and this is very easy to do especially in the tank house. Even at a distance of several feet the readings of a portable instrument are thrown out a division or two on the scale and where accuracy is desired the average of two readings with the instrument turned 180 deg. should be used.

The resistance of the leads on a switchboard ammeter is generally about 5 per cent of that of the instrument, and the screw connections must be kept clean. If it is found necessary to lengthen the leads, care must be taken that the resistance is kept constant by a proportionate increase in size of wire used. The leads should be twisted and kept from swinging loosely in the presence of stray field. Otherwise there is a dynamo action which the millivoltmeter is sensitive enough to indicate by a pulsating needle.

When several high-capacity ammeters are in use, it is advisable to have them interchangeable. The various instruments may then be checked at any time by connecting them to the same shunt. Connections should also be arranged, if possible, to put the shunts in series, when they too may be checked.

The question of proper section for busbars has been fully discussed in a previous article (Chem. & Met. Eng., Nov. 15, 1916). No insulation is used and faced metal to metal joints without amalgam, tightly bolted together, are satisfactory at 200 amp. per sq.in. contact surface. Either rolled or cast bars may be employed. The bars from the switchboard to the tanks are best carried overhead and the positive and negative leads kept some distance apart.

Furnaces

For smooth operating there should be at least six furnaces, three anode and three wirebar units, two of each being in service and one out for repairs. For a capacity of 100,000 tons a year, and allowing for Sundays and holidays out, we should have 600 charges a year of 333,000 lb. each plus scrap, etc., which is a furnace of fair size, although it is possible to build them very much larger.

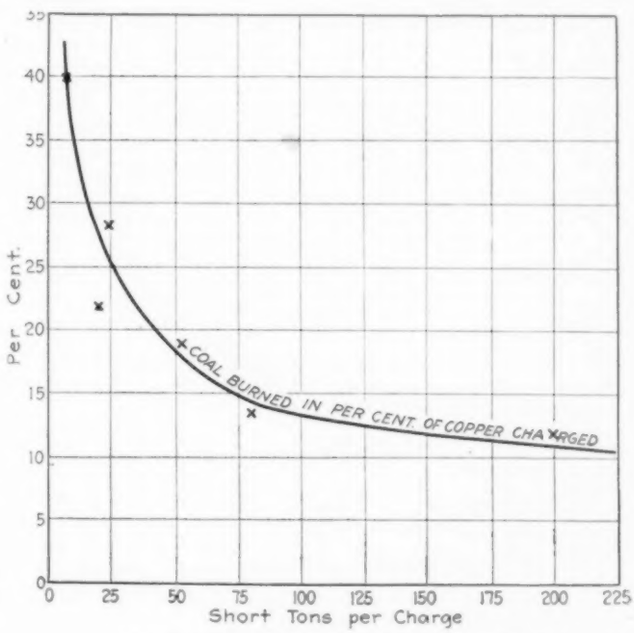


FIG. 3. FUEL RATIO OF FURNACES

The limit of size has been the ability to charge, refine and cast the charge in 24 hr. With hand charging and ladling, using the same men for both operations, 60,000 lb. is a large furnace. If a fresh crew is used for charging and as many ladlers employed as can be accommodated at the ladle door, 100,000 lb. can be reached. With hand charging but mechanical ladling, 300,000 lb. is

possible, using three charging doors. With full mechanical charging and ladling 500,000 lb. is easily reached, and using two charging and ladling machines even a larger capacity can be attained.

The fuel economy increases rapidly with the size of furnace as indicated by the curve in Fig. 3. Labor charges also fall up to the point of mere duplication of machine units. Repairs fall at first, but a very large furnace is likely to incur heavier repairs than one somewhat smaller. This is especially true where too great a span of roof is attempted. A refining furnace is subjected to much greater and more rapid temperature changes than an ore reverberatory.

Small silica furnaces produce excessive slag as they run hot and have an undue proportion of wall exposure. A 40,000-lb. silica furnace will form 4 or 5 per cent of slag on a wirebar charge, whereas a similar furnace of 150,000 lb. or over to the charge can be held down to half that amount. With basic side walls there is a substantial decrease in these figures, and with a full basic furnace operating on a charge of good quality the slag made can be held down to 0.5 per cent or better.

Altogether a furnace casting a charge of 300,000 lb. or more may be considered a thoroughly economical unit.

Silver Refinery

A 100,000-ton plant will call for a silver refining department of reasonable size. At 1.25 per cent slimes there would be four tons of slimes a day to treat, calling for a doré reverberatory of about twenty tons capacity, just the size of the first copper furnaces. It is desirable to use but a single furnace in order to hold at a minimum the large bottom absorption of values. A spare furnace may be held in reserve and in case of accident or at inventory time substituted, the first unit being completely dismantled at that time and its silver content recovered.

A very small plant can best sell its slimes to a lead refinery, but owing to the difficulty in getting a fair sample of such rich material this is not desirable when the tonnage is of any size. Small plants would use a cupel furnace and sulphuric acid parting, while reverberatory smelting followed by electrolytic parting is generally employed in large ones.

While the purifying system affords a suitable outlet for accumulations of sodium salts in the electrolyte, niter may be used to remove the copper from the slimes. Where closed cycle operation is undertaken the copper is generally oxidized by roasting. Either method gives good metallurgical results.

Purifying

The metallurgical principles upon which the choice of a purifying system must be based have been fully covered in a previous article (Chem. & Met. Eng., June 15, 1917).

Where insoluble anode tanks are employed for the complete removal of the copper from batches of electrolyte, ample provision must be made for the very low current efficiency of these tanks. Should a bluestone plant be employed, the design will be based upon the quantity of shipping salt to be produced. The crystallizing tank space employed in different plants varies considerably. A fair average figure, making allowance for the recrystallization of fines, is 58 cu.ft. per short ton per month of marketable bluestone. When estimating the proportion of impurities removed from the electrolyte, it must be remembered that a large part of the copper in the bluestone comes from the shot towers and not from the electrolyte. For each 1,000 cu.ft. of crystallizing space, allowance should be made for, say, 175 cu.ft. shot towers, 375 cu.ft. shot tower receiving tanks, 225 cu.ft. slimes settling tanks, 250 cu.ft. boiling tanks, and 275 cu.ft. iron cementation tanks. These ratios, however, may be varied between rather wide limits to suit individual cases differing in analysis of electrolyte, character of shot, climate, etc.

General

Two main principles should be kept in mind in the program of operation of any plant. The first is that all the impurities possible should be eliminated at the anode furnaces, using basic furnaces if necessary. It is much more costly to throw this burden upon the tank house and silver refinery.

The second is to do everything possible to facilitate uniformity of operating conditions. As a general rule anodes of constant composition, a uniform current density and a single electrolyte should be used throughout the tank house.

Artificial Graphite

Graphite is manufactured by the Acheson Graphite Co. at Niagara Falls, N. Y. This company utilizes the electric power generated at the Falls to make graphite from anthracite coal or from petroleum coke. This product is used mainly in lubricants, but it is also used in paints, foundry facing, preventives of boiler scale, and fillers for batteries.

Artificial graphite may be used for any purpose for which natural graphite is employed, according to the United States Geological Survey, except in the manufacture of large crucibles. Patents have been issued recently, however, for methods of manufacturing crucibles in which artificial graphite may be used. Artificial graphite is peculiarly adapted to the manufacture of certain graphite products, among them graphite electrodes, which are not made from natural graphite and for which the demand has greatly increased in recent years. The table below, published by permission of the Acheson Graphite Co., represents only the manufactured graphite that comes into competition with natural graphite.

GRAPHITE MANUFACTURED BY THE ACHESON GRAPHITE CO., 1915-19

	Pounds
1915	5,084,000
1916	8,397,281
1917	10,474,649
1918	9,182,272
1919	8,163,177

New Cold Process for Vulcanizing Rubber

It is reported that a very important discovery of a new process of vulcanizing rubber has been made by Prof. Peachey of the Manchester (England) College of Technology—important because it is a method of cold vulcanizing. It makes use of two gases, hydrogen sulphide and sulphur dioxide, which react on each other to produce water and free sulphur. The professor has found that when crude rubber, either in a solid form or in solution, is treated with these two gases the sulphur produced by their interaction vulcanizes the rubber. If the rubber is mixed with a waste material such as sawdust or leather scraps or paper, and the mixture is vulcanized, the resultant materials will serve a variety of useful purposes.

Properties and Constitution of Glues and Gelatines—V

A Study of Adhesive Properties—The Relation of Jell Strength to Shear Strength; of Jell Strength to Tensile Strength; of Viscosity, Melting Point, Origin of Stock, Joining Pressure and Prolonged Heating to Shear Strength*

BY ROBERT H. BOGUE, PH.D.

THE criterion for the value of a glue as a joining agent must, in most cases, be the actual strength developed and maintained by that glue in service, and any method of grading whereby relative strengths are not truly expressed is pernicious and unscientific. Indeed, actual strength tests may be considered as the only absolutely dependable basis upon which to evaluate glues, and for some very particular purposes, as in the selection of glues for airplane service by the United States Forest Service,[75] such tests are consistently made upon all samples before approval. But, in general, strength tests are not made for several reasons. The machinery for making such tests is heavy and expensive. The time required is long—about seven days. The technique requires very careful and precise handling in order to obtain accurate results. Other methods of grading have long been in use, and are believed to be reasonably satisfactory. And, most important perhaps, the strength test itself has ever been more or less unsatisfactory, even in the hands of skilled research men. There are many elements concerned in the results obtainable besides the glue itself. There may be mentioned the hardness and uniformity of grain of wood, and its moisture content; the varying degree of perfection obtained in making the joint; the distribution of the pressure over the surface of the joint; the difficulty of duplicating the joining pressure exactly. These and many other less obvious factors all make for inexact, and not readily duplicatable, results.

NO STANDARD MECHANICAL STRENGTH TESTING METHOD

Again, many methods have been suggested in the literature for making the strength test, but there is as yet no generally accepted method which may be considered as standard. Rudeloff[76] used red beech wood, 185 mm. long, 125 mm. broad, 50 mm. thick, placed so that the glued surfaces crossed at right angles. They were later torn apart. A. H. Gill[77] used maple blocks shaped like cement briquets, glued together endwise, and broken in cement-testing machines. He also made briquets of fullers earth, diatomaceous earth, quartz sand, and sawdust, but could not obtain consistent results. He then dipped strips of filter paper into glue solutions, and when dried broke them with the Mullen paper tester. His results by this method were more concordant. G. S. Hopp[78] molds glue into strips, allows them to dry on tin or aluminum nets, machines down to dimensions desired, and pulls apart in torsion machine. He obtains the stretch and tensile strength, which vary from the average 1 to 3 per cent. The Forest Service of the United States Department of Agriculture has developed a strength test[79] which seemed somewhat more satisfactory than any of the others. Maple blocks are selected which have been carefully cured and are of uniform grain. These are 12 x 2½ x 1 in. They are carefully resurfaced, heated to 40 deg. C. and joined. After subjection to a uniform pressure for 24 hr., and allowed to stand seven days to dry out, these are sawed into blocks such that the area of the joint is exactly 4 sq.in. These are then broken by shearing the two blocks of wood apart. By taking averages of several tests, the results obtained are reasonably concordant.

Because of the unsatisfactory status of the strength test, and in order to determine specifically the relation between other properties of glues, and their strength in service, this series of experiments was undertaken. We will consider:

The Relation of Jell Strength to Shear Strength.
The Relation of Jell Strength to Tensile Strength.
The Relation of Viscosity to Shear Strength.
The Relation of Melting Point to Shear Strength.
The Relation of Origin of Stock to Shear Strength.
The Relation of Joining Pressure to Shear Strength.
The Effect of Prolonged Heating Upon Shear Strength.

THE RELATION OF JELL STRENGTH TO SHEAR STRENGTH

The method used in this, and in all of the other experiments in this paper, with the exception of that section upon tensile strength, was that described as adopted by the Forest Products Laboratory at Madison, Wis. The greatest of care was used in selecting only uniformly grained blocks, in obtaining a perfectly plane joining surface, and making the joint under exactly uniform conditions. The glue was dissolved in varying amounts of water, heated to about 65 deg., and applied to the wood, which was heated to about 40 deg. C. Four test blocks, each with a glued area 2 in. square, were cut from each of the larger glued blocks, and these were placed in a special shearing machine, of the type used by the Forest Products Laboratory, and pressure applied until they broke. The pressure reached and the condition of the fracture were noted.

In the first experiments the joints were pressed together in wooden clamps, care being used to produce as nearly equal pressures as possible on successive joints. The pressure obtained by these clamps was measured by a spring and deflectometer, and found to give a total of about 350 lb., or, as the area of the joint per clamp was about 13 sq.in., a pressure of about 27 lb. per sq.in. was obtained. Dilutions were made of from one part of glue to one and a half of water in the lowest grades up to one of glue to five parts of water in the highest. This was done in an attempt to

*For Parts I, II, III and IV, see CHEM. & MET. ENG., vol. 23, Nos. 1, 2, 3 and 4, July 7, 14, 21 and 28, 1920, pp. 5, 61, 105 and 154.

[75] See *Mech. Eng.*, vol. 41, (1919), p. 382.

[76] *J. Soc. Chem. Ind.*, vol. 37 (1919), p. 743A.

[77] *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 102.

[78] *Ibid.*, vol. 12 (1920), p. 356.

[79] *Loc. cit.*

determine the concentration at which the maximum strength was developed. The glues used consisted of the standard grades from the highest to the lowest of both hide and the bone products. This means that glues with a regular variation in jell strength were used.

An examination of the data furnished from this series of experiments will reveal that although there is in general a decrease in strength with decrease in grade, yet this is by no means consistent. Many low-grade glues have an apparently greater strength than a much higher grade product, and vice versa. But even this feature does not remain in the leastwise constant at the slightly varying concentrations used. In fact, we must accept the conclusion that the results obtained are erratic and altogether undependable.

TABLE XLIV. SHEAR STRENGTH OF STANDARD GLUES AT VARYING CONCENTRATIONS

(Joined in clamps)

Concentration	H_1	H_2	H_3	H_4	H_5	H_6	
1 to 2½	.....	2,630	2,780	2,300	1,260	1,830	...
1 to 2¼	2,240	2,360	2,990	1,710	1,620	1,310	...
1 to 2	2,320	2,730	1,880	1,980	2,000	1,470	...
1 to 3	2,500	2,040	2,420	1,720	1,480	1,340	...
1 to 5	640	1,120	840	740	910	470	...
Average except 1 to 5	2,350	2,440	2,515	1,925	1,590	1,485	...
Concentration	B_1	B_2	B_3	B_4	B_5	B_6	B_9
1 to 1½	.....	.....	.....	.....	.....	.....	950
1 to 1¾	.....	.....	.....	.....	.....	1,580	710
1 to 2	.....	1,910	1,700	1,740	1,410	1,380	410
1 to 2½	2,080	2,030	1,920	2,120	1,430	1,460	650
1 to 2¼	1,920	1,180	2,020	760	1,490	1,560	...
1 to 2¼	1,420	1,560	1,200	1,500	1,160	.....	...
1 to 3	1,930	.....	.....	.....	.....	.....	...
1 to 5	700	1,010	750	560	580	300	...
Average except 1 to 5	1,835	1,670	1,710	1,530	1,370	1,495	680

It occurred to the writer that, although care was used to obtain equal pressures upon all joints, it might be that such inequalities as did exist in the pressure of joining might be sufficient to account for the inconsistent results obtained. Experiments were therefore initiated which proved this to be the case. These will be described later.

The above experiment was therefore repeated, in part, by placing each set of blocks, after joining, between parallel plates in a torsion machine, and applying a pressure uniformly of 200 lb. to the sq.in. This pressure was selected from the consideration, described hereafter, that at that pressure slight variations in pressure will have only a slight effect upon the strength of the joint, and also that the strength developed at this pressure is nearly a maximum. Only one concentration was used, e.g., one part of glue to two and a half parts of water.

TABLE XLV. SHEAR STRENGTH OF STANDARD GLUES, JOINED IN TORSION MACHINE

Joining pressure, 200 lb. per sq.in. Concentration, 1 to 2½

Hide Glues	H_1	H_2	H_3	H_4	H_5	H_6
Average strength per sq.in.	2,940	2,840	2,390	2,685	2,185	1,980
Per cent wood broken	100	75	15	50	0	0
Bone Glues	B_1	B_2	B_3	B_4	B_5	B_6	B_9
Average strength per sq.in.	2,750	2,310	1,645	1,590	1,360	1,180	485
Per cent wood broken	25	0	0	0	0	0	0

The results were this time satisfactory in that in every case (except one) the strength of the joint varies directly as the grade, or jell strength. The cause of the one exception was at first not understood, but has since been satisfactorily accounted for, and will later be discussed. The maximum strengths were not in every case measured, due to the fact that in the highest grade glues, the glue was stronger than the wood, but by noting the relative percentage of the several fractures which occurred in the wood instead of in the glued joint, our conclusions are relatively satisfactory, and entirely dependable.

Other series were tested with the object of eliminating any possible effect which the viscosity might have upon the strength of the joint. Glues were selected which were of uniform viscosity but of varying jell strength, and tested as before. The results so obtained corroborate the data of the previous experiments, that the strength of a glue in service is a function of the jell strength, and this irrespective of the viscosity. Table XLVI will illustrate this point.

TABLE XLVI. RELATION OF JELL STRENGTH TO SHEAR STRENGTH

Joining pressure, 200 lb. per sq.in. Concentration, 1 to 2½

Jell strength	H_2	H_4+	H_4-
Viscosity (capillary tube)	50	50	50
Average strength per sq.in.	2,670	2,300	1,850
Per cent wood broken	65	8	0

The Relation of Jell Strength to Tensile Strength

It seemed desirable to obtain, if possible, a shearing in which the break would occur entirely within the joint, and not in the wood. It seemed possible that if joints were made and sawed so that they might be pulled apart, the jaws of the torsion machine might hold the fibers of the wood so tightly that they could not slip before the glue at the joint gave way. Accordingly, blocks were joined and sawed into sections 6 x 1 in. and the joint cut to an area of 4 sq.in. The standard glues were used at a concentration of 1 to 2½.

TABLE XLVII. TENSILE STRENGTH OF STANDARD GLUES

Pressed in clamps. Concentration, 1 to 2½

Hide glues	H_1	H_2	H_3	H_4	H_5	H_6	
Average strength per sq.in.	540	345	318	340	304	290	...
Per cent wood broken	75	25	50	25	0	0	...
Bone glues	B_1	B_2	B_3	B_4	B_5	B_6	B_9
Average strength per sq.in.	435	390	385	295	230	210	130
Per cent wood broken	25	30	0	0	0	0	0

The desired effect was not, however, produced, as, on pulling apart, the fibers of the highest grade glues slipped through the jaws of the machine. This method did, however, confirm the results obtained by the other method, and placed the order of strength exactly as had been previously obtained. It is noticeable that the pull necessary to break the joint is small in comparison with the push necessary to shear the blocks apart by the other method. As this method had no advantages over the former one, and some disadvantages, it was not used in any further tests.

The Relation of Viscosity to Shear Strength

The actual significance of viscosity in the evaluation of a glue has been a point upon which there has been much diversity of opinion. It is most commonly stated, however, that viscosity is a measure of the water-taking capacity of the glue, which means that a glue with high viscosity may be worked at a greater dilution, and therefore at greater economy, than another one, similar in all respects, except of low viscosity. Indeed, A. H. Gill[20] came to the conclusion that "tensile strength, jelly test and viscosity bear no relation to each other." These

[20] *Loc. cit.*

conclusions were undoubtedly reached through an insufficiency of data, and failure to eliminate all but one variable in any given set of experiments. The author has shown that the strength of a glue is a function of the jell strength, and, in general, the viscosity varies as the jell strength, but a set of glues might easily be selected which would vary regularly in viscosity, but the curve of jell strength might be a zigzag. In this case the strength of the glues, being influenced by jell strength, would probably also be irregular.

Accordingly, groups of glues were selected which

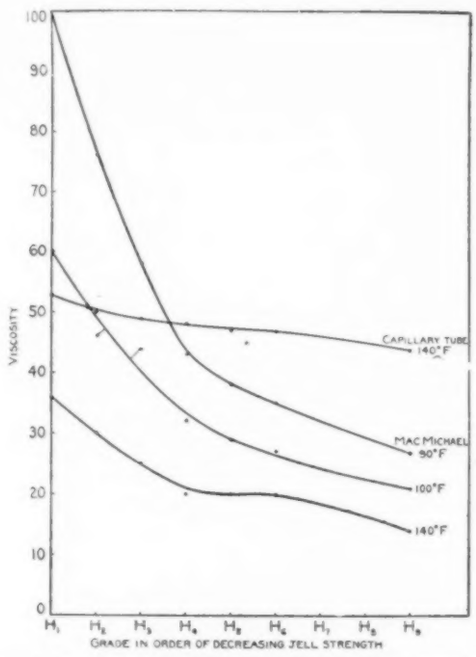


FIG. 22. RELATION OF VISCOSITY TO JELL STRENGTH. HIDE GLUES

were throughout of the same jell strength, and divided into sub-groups, representing varying viscosities. Joints were made with these in the manner already described. The concentration was one part of glue to two and one-half parts of water. They were uniformly subjected to a joining pressure of 200 lb. per sq.in.

TABLE XLVIII. RELATION OF VISCOSITY TO SHEAR STRENGTH.

Jell strength	H_2	H_3	H_5
Viscosity (MacMichael 140 deg. F.)	36	28	24
Strength per sq. in.	2,640	2,330	2,275
Per cent wood broken	30	6	0

The data show that in all cases the strength of the joint is greater with the high viscosity glues, and decreases regularly as the viscosity.

The Relation of Melting Point to Shear Strength

It has been demonstrated that the strength of a glue in service is a function both of the jell strength and of the viscosity. Were we to consider jell strength as the measure of strength, then, although probably three-quarters of all glues would be correctly evaluated, yet the remaining quarter, due to an abnormally high or an abnormally low viscosity, would be either stronger or weaker than the grade they were assigned to represent. And if we considered viscosity (as usually taken at 140 deg. F.) as the measure of strength, the same reasoning would assign an even greater proportion of glues to grades which were not indicative of their true strength value.

The writer has shown previously[51] that both the jell strength and the viscosity are functions of the melting point. He has also shown that if we take the viscosities at regularly decreasing temperatures the viscosity curve will gradually merge into the jell strength curve. It is, therefore, evident that there must be a curve intermediate between that of the viscosity at 140 deg. F. and the jell strength which will represent more accurately than any other the exact relative value of all glues. This is obviously the melting point curve. It has also been shown that, since the viscosity curve and the jell strength curve merge into one another as the temperature is lowered or raised, a measurement of viscosity at low temperature serves admirably as a measure of melting point.

We are now, therefore, in a position to state with assurance that the strength of a glue is normally always proportional to its melting point, and that the melting-point method of evaluation is inevitably superior in accuracy of grading, with strength in service as the criterion, to either a jell strength or viscosity (at 140 deg. F.) method.

We find that this conclusion explains many points which were otherwise not understood. It has been noted that the order of strength in glues H_3 and H_4 was reversed from what we had expected. But a melting-point determination reveals that in this case H_4 is the higher, and should, therefore, be expected to have a greater strength. Apparent abnormalities in many other glues are similarly accounted for.

In order to determine the exact nature of this

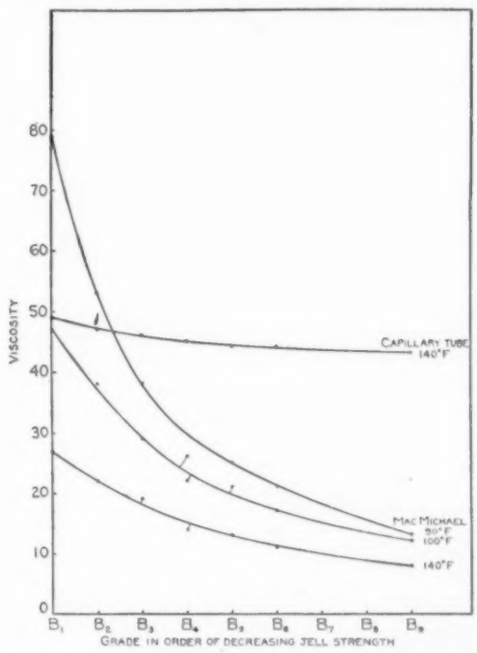


FIG. 23. RELATION OF VISCOSITY TO JELL STRENGTH. BONE GLUES

melting-point strength curve about 300 measurements were made on all grades of glues.[52] Measurements were made at temperatures of 140, 100 and 90 deg. F. A remarkably lengthened curve is obtained at 90 deg. F., of such a nature that there is a difference in the reading of from 5 to 25 points between any two grades. This makes the precise allocation of any glue an easy matter, and not subject to improper grading due to trifling

[51] See p. 64.

[52] See p. 66 for details and method.

variations in technique. The curve at 90 deg. F., or about 32 deg. C., is therefore recommended as the most suitable temperature for the melting-point determination. At lower temperatures many glues would be difficult to handle, and their melting-point curve would doubtless have been drawn too close to their jell-strength curve to serve the end of obtaining the most accurate evaluation.

TABLE XLIX. AVERAGE VISCOSITY (MacMICHAEL) OF ALL GLUES AT 140, 100 AND 90 DEG. F.

	Capillary Tube Viscosity 140 deg. F.	MacMichael Viscosity 140 deg. F.	MacMichael Viscosity 100 deg. F.	MacMichael Viscosity 90 deg. F.
H_1	53	36	60	100
H_2	50	30	46	76
H_3	49	25	44	58
H_4	48	20	32	43
H_5	47	20	29	38
H_6	47	20	27	35
H_9	44	14	21	27
B_1	49	27	47	79
B_2	47	22	38	53
B_3	46	19	29	38
B_4	45	14	22	26
B_5	44	13	21	25
B_8	44	11	17	21
B_9	43	8	12	13

A summary of the data is given in Table XLIX and the curves are shown in Figs. 22 and 23.

THE RELATION OF ORIGIN OF STOCK TO SHEAR STRENGTH

It seemed very desirable to know if the nature of the origin of the stock used in the manufacture of glue might affect the strength of the product in some way that might not be revealed by the customary tests of

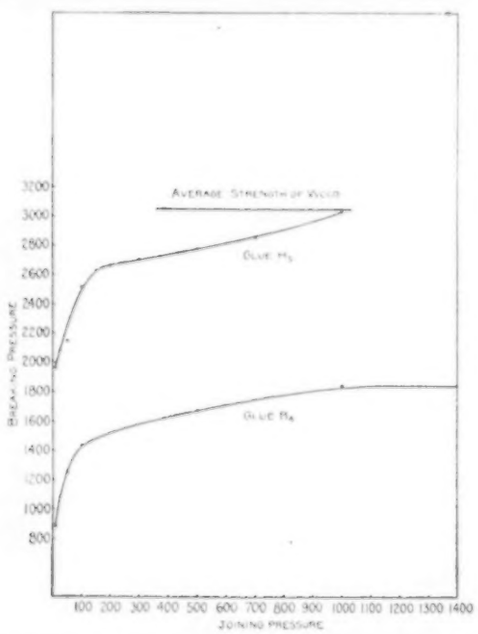


FIG. 24. EFFECT OF JOINING PRESSURE UPON STRENGTH

jell strength or viscosity. Accordingly, glues were selected as follows: Series C consisted of glues of uniform test and produced from similar stock. Series D consisted of glues of uniform test but each group made from different types of stock. Series E consisted of glues of varying test and obtained from similar stock. Tests were made in the usual manner, at a concentration of one part of glue to two and a half parts of water, and joined at a pressure of 200 lb. per sq.in.

The results obtained do not reveal any variation in strength with the type of stock used which is not *similarly revealed* by the measurements of jell strength and viscosity. In series C the strength of the three sets are practically identical, as would be expected from their uniform test and similar origin. In series D the jell strength is nearly constant, but the nature of the stock varies, and the viscosity varies. The strength is found to vary as the viscosity. In series E the

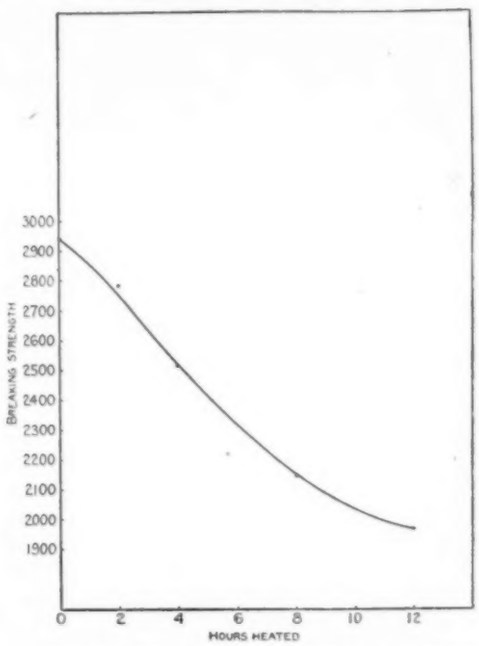


FIG. 25. EFFECT OF HEATING A HIGH-GRADE GLUE IN SOLUTION UPON STRENGTH

strength is found to vary as the jell strength and viscosity, which run parallel, regardless of the fact that the glues are derived from similar stock. So it seems

TABLE L. INFLUENCE OF ORIGIN OF STOCK UPON STRENGTH

Joining pressure 200 lb. per sq. in. Concentration 1 to 2½

Series C: Uniform test; similar stock:			
Jell strength	H_3	H_3	H_7
Viscosity (capillary tube 140 deg. F.)	51	51	51
Strength per sq.in.	2,260	2,325	2,280
Series D: Uniform test; different stock:			
Jell strength	H_2	H_2 —	H_2
Viscosity	53	52	51
Strength per sq.in.	2,900	2,710	2,440
Series E: Varying test; similar stock:			
Jell strength	H_3 +	H_4	H_6 —
Viscosity	53	52	46
Strength per sq.in.	2,720	2,155	1,690

that a consideration of the jell strength and viscosity, or the melting point, will correctly establish the value of the product with reference to strength, regardless of the origin of the stock.

THE RELATION OF JOINING PRESSURE TO SHEAR STRENGTH

As soon as it became evident that slight variations in the pressure at which the blocks were joined produced a decided variation in the strength of the joint, experiments were started to establish exactly the relation which existed between the joining pressure and the strength of the joint. A medium-grade hide glue and a medium-grade bone glue were used. They were made up to a concentration of one part of glue to two and a half parts of water, and on joining subjected to pressures of from 10 to 1,400 lb. per sq.in. This was accomplished by pressing between the parallel plates of a torsion machine.

The data obtained, when plotted, reveal curves which show the strength to increase very rapidly with increase in joining pressure up to about 200 lb. per sq.in. Beyond this point the strength continues to increase gradually up to 1,000 lb. per sq.in. The hide glue had here obtained nearly the strength of the wood. On increasing the joining pressure of the bone glue beyond this point no further strength was developed, but it remained constant to 1,400 lb. per sq.in. It is at once evident that if maximum strength is desired a high pressure should be used—certainly not less than 200 lb. to the sq.in. And not less important it should be pointed out that a low-grade glue at a high pressure may be made to do the work and produce joints of as great strength as a high-grade product at a low pressure.

TABLE LI. EFFECT OF JOINING PRESSURE UPON STRENGTH.
Concentration, 1 to 2½.

Joining Pressure	10	25	50	100	150	200	300	500	700	1,000	1,400
Glue H_5	1,965	2,080	2,160	2,520	2,615	2,660	2,700	2,785	2,860	3,030	....
Glue B_4	885	....	1,255	1,435	....	....	....	1,675	....	1,845	1,845

A summary of the data is given in Table LI, and the curves are shown in Fig. 24.

The Effect of Prolonged Heating Upon Shear Strength

Some joiners are in the habit of buying the highest grades of glue and heating them in solution for some time before using. This process is known to lower the viscosity and the jell strength, but it results in increased tackiness and the joiners who practice this method claim they can produce stronger joints than by any other procedure. In order to ascertain if heating could actually produce a stronger product, in spite of its apparent contradiction to theory, the highest grade glue was subjected to heating at about 80 deg. C. for periods of 2, 4, 8 and 12 hr. The concentration was one part of glue to two and a half parts of water. The joining pressure was 200 lb. per sq.in.

The data show the strength of the glue to decrease regularly as the period of heating, and when plotted show nearly a straight line. This conclusion agrees with results obtained by Linder and Frost,[88] who find that a heating at 150 deg. F. for 20 hr. produces a loss in strength of 30 to 45 per cent. Our data show that in 2 hr. the strength has dropped from H_5 to the equivalent of $H_{4.5}$; in 4 hr. to H_4; in 8 hr. to H_3; and in 12 hr. to H_2. This experiment affords conclusive proof that the heating of a glue produces a distinct and very appreciable loss in strength, and that this loss in strength is proportional to the period of heating.

TABLE LII. EFFECT OF HEATING UPON STRENGTH. GLUE H_1
Temperature, 80 deg. C. Joining pressure, 200 lb. per sq. in. Conc., 1 to 2½

Hours heated	0	2	4	8	12
Viscosity (MacMichael 140 deg. F.)	220	105	68	54	50
Strength per sq. in.	2,940	2,785	2,515	2,145	1,965

The averages are given in Table LII and the curve is shown in Fig. 25.

Summary of Results

The following conclusions may be drawn from the several experiments described in this paper:

The strength of a glue in service is a function of the jell strength.

The strength of a glue is a function of the viscosity.

The strength of a glue is directly proportional to the melting point.

The melting-point method for evaluation of glues by the process described is recommended as yielding a true index of actual strength in service.

Variations in the origin and type of stock used in the manufacture of glue produces no variations in the strength of the product which are not made manifest by jell strength, viscosity, or melting-point determinations.

The strength of a glued joint varies directly as the joining pressure applied, up to about 1,000 lb. per sq.in. Below 200 lb. to the sq.in. the variation is large. Above that the variation is small.

The strength of a glue decreases regularly as the period of heating in solution.

The method of testing the strength of glued joints as developed by the Forest Products Laboratory at Madison, Wis., is recommended to scientific workers as one which, with careful technique, will give satisfactory results.

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New Jelly Product From Grape Juice Waste

As a result of the increased use of grape juice particularly since prohibition went into force, a new product has been developed from the waste material left after the expulsion of grape juice. This waste product, called pomace, is composed of the skins and pulp and can be made into a fine jelly.

The United States Department of Agriculture, in co-operation with the large grape juice producers in the state of New York, have made experiments with this material, which show that a jelly comparable in cost with apple jelly can be made. In addition the seeds may easily be separated and an edible oil made from them.

Legal Notes

By Wellington Gustin

Establishing the Market Value of a Product—The Damages to a Purchaser for Resale

Judgment for George O. Seward against the Pennsylvania Salt Manufacturing Co. has been reversed by the Supreme Court of Pennsylvania and a new trial awarded. The suit was one for damages for an alleged breach of contract in the purchase of hydrate alumina. The salt company is located at Natrona, Pa., and Seward is a metallurgical engineer of New York. The latter sought to purchase the chemical product for use during 1916, and the company offered to furnish him 100 tons a month from March to December, inclusive, 1916, at 4c. per lb. f.o.b. Natrona, net cash, offer open until November, 1915. On Nov. 11, 1915, Seward wrote the company accepting the offer of 100 tons monthly.

The company requested the name of the buyer so that contracts might be written up, etc. Seward did not reply to this request, and on Jan. 22, 1916, the company again wrote that as it had heard nothing from him since its request, it assumed his plans had not developed as anticipated and therefore the matter was considered a "dead" issue, but Seward replied that the matter was not a "dead" issue and that he would send shipping instructions before March 1, for the 100 tons to be delivered to him during March.

Company Refuses to Deliver

The shipping instructions were given, but the company refused to deliver the specified hydrate alumina or any part thereof and set up as a defense that the offer to sell was made upon the faith of an express parol agreement that Seward was to organize a new company for the manufacture of aluminum by which all of the chemical products should be used and none resold, and that otherwise the offer would not have been made.

It was admitted that no new company was organized nor was the product required in Seward's business. Correspondence between the parties referred to companies in which he was interested and to a proposed new company. But this constituted no agreement as alleged by the salt company. To establish that parol evidence was introduced and largely relied upon. The jury found for Seward and the court awarded him $34,500.

Difficult to Assess Damages

Upon the appeal the important question was that of damages. The Supreme Court stated several important rules that should be here repeated. The general rule is that in an action for failure to deliver goods according to sales contract the measure of damages is the difference between the contract price and the market value at the time and place of delivery, with interest [2 Sedgwick on Damages (9th Ed.) par. 734]; and plaintiff may recover such damages without having supplied his wants elsewhere. The trial judge so instructed the jury, but the difficulty in this case was the lack of evidence of market value. The only proof as to that was the amount for which Seward contracted to resell 25 tons of the March delivery, and the price at which the company supplied its other customers during the months in question. Those sales were individual transactions in small amounts and not made in the open market, and not sufficient to establish the market value, especially of such quantities, said the court.

Hydrate alumina is manufactured at other chemical works, but there was no evidence as to price for which it there sold, or as to its general selling price in open market. It may not at all times be possible to establish a general selling price, and in such cases actual market value may be shown by proof of facts and circumstances fixing to a reasonable degree of certainty the amount the product would bring if offered at ordinary sale.

No Market Value for Hydrate Alumina

Again, where a product is not obtainable in the open market a plaintiff could recover his actual damages by proving such damages through showing that he required the products in his business, that he procured them elsewhere, or made them, at a cost greater than the contract price. In this case Seward proved no such actual damages. In his behalf it might be urged that he could have resold the hydrate alumina at a profit. But, said the court, how can it be determined that an article without market value can be resold at a profit? The chances thereof are too speculative to form the basis of a recovery. (106 Pa., 237.) Moreover, the anticipated profits on a resale are not recoverable unless in contemplation of the parties when the original contract was made, and here they were not. (26 L.R.A., N.S., 1,191.)

Therefore, unless the proof shows the subject of the contract had a market value, and that greater than the contract price at the time of delivery, so as to bring the case within the general rule above stated, the buyer can recover only nominal damages.

The judgment against the salt company was reversed because the lower court erred in treating the evidence as sufficient to justify a finding of market value, which it was not.

Debtor's Check Not Payment Until Check Is Paid

Payment by check was the subject of a recent decision where plaintiff had sued for the agreed value of goods sold defendant. On appeal the Supreme Court said that a check of the debtor in liquidation of his own debt is not payment until paid, unless in some very special case such check was taken in absolute extinguishment of the debt—which case can hardly be supposed.

The acceptance of buyer's check by sellers did not constitute payment, where no payment had been made on check, and this is true although the sellers had previously accepted buyer's checks as payment when checks were paid; the only inference, if any, from such practice being that tender of check would prevent the sellers from asserting a default by reason of non-payment or non-tender.

If for any reason the seller failed to deposit the buyer's check, such buyer is bound to keep his tender of payment good, and when sued to pay the money into court. Further, the court said, the mere fact that the sellers of goods, under agreement giving the buyer a right to certain discount upon payment within a certain time, permitted the buyer to deduct the discount on two or three occasions when payment was not made within the time of the credit did not give the buyer a right to such deduction in all subsequent transactions.

Molybdite: Its Occurrence, Detection and Determination in Partly Oxidized Molybdenite Ores

A Review on the Composition of Molybdite Ore, Its Occurrence and Concentration — Chemical Test for Molybdite in the Presence of Molybdenite — Outline of Methods for Qualitative and Quantitative Analysis

BY J. P. BONARDI*

THERE are several oxidized molybdenum minerals found in the United States,[1] but none are of commercial importance at the present time except molybdite ($Fe_2O_3.3MoO_3.7\frac{1}{2}H_2O$), which commonly occurs with molybdenite as an alteration product and the recovery of which is difficult by the flotation process of ore dressing in use for the sulphide mineral. Oil flotation has proved so successful, especially on low-grade disseminated molybdenite (MoS_2) ores assaying below 0.5 per cent Mo, that it is being used almost exclusively for making high-grade concentrates. Molybdenum in the form of the oxide is unrecoverable by the ordinary flotation processes adopted for the recovery of the sulphide mineral; consequently, it tends to go to waste along with the tailings. The seriousness of this loss can be judged when it is known that one of the largest molybdenite orebodies in this country, situated at Climax, Col., carries from 10 to 20 per cent of the molybdenum content in the form of the above-mentioned oxide mineral.

It is said that the flotation mill at Climax for treating the crude ore has at present a capacity of 1,000 tons a day; and at this rate of production the ore reserves already developed in this ore deposit alone insure steady operation for more than thirty years. The importance, then, of recovering the molybdite mineral should not be overlooked or underestimated. The application of sodium sulphide (Na_2S) to a flotation charge under the proper conditions has resulted in recovering a considerable part of the oxide mineral. One of the chief difficulties in a sulphidizing treatment is the fact that molybdic oxide is readily soluble in an alkaline solution, so that the sulphidizing treatment must be carried out in as near a neutral solution as is possible. Molybdenum can, however, be recovered from an alkaline solution by adding $CaCl_2$ until causticity has been neutralized, followed by vigorous boiling.[2] The determination, then, of the oxide mineral becomes an important factor in metallurgical calculations, especially so if the relative floatability of each mineral is desired. A search through the literature revealed the fact that no methods were given for the determination of molybdite in molybdenum minerals.

Besides the large known deposit at Climax, it is commonly the case to find that oxidation of the molybdenite on the outcrops of such veins has resulted in the formation of considerable molybdite. Usually it disappears entirely at depth, excepting the case at Climax, where it occurs practically throughout the orebody at present blocked out. The oxidation is still prominent down to 350 ft. below the surface.[3]

Horton,[4] in speaking of molybdite, states:

"Molybdite is a hydrous ferric molybdate ($Fe_2O_3.3MoO_3.7\frac{1}{2}H_2O$) and theoretically contains 39.63 per cent of molybdenum. . . . It is an alteration of molybdic acid (liberated by the oxidation of the molybdenite) and limonite. The formation of the limonite in many cases may have resulted from the weathering of pyrite which is commonly associated with the molybdenite, simultaneously with or previous to the weathering of the molybdenite.

"For many years the erroneous idea has existed that molybdite agrees in composition with the artificial molybdic trioxide obtained by oxidizing molybdenite. The present textbooks on mineralogy almost universally persist in this error, giving the composition of molybdite as MoO_3, and stating that the pure mineral contains 66.7 per cent of molybdenum. That such is not the case was first called to the author's attention by chemical tests of a sample of molybdite which from microscopic examination seemed to be practically pure. The presence of a large percentage of iron was determined, and the same results obtained from tests on other samples of molybdite from different localities led the author to believe that the iron was an essential part of the mineral. Schaller[5] had not only proved the presence of combined iron in molybdite but had definitely established its composition as $Fe_2O_3.3MoO_3.7\frac{1}{2}H_2O$."

TESTS FOR MOLYBDITE

Regarding tests for molybdite, Schaller[5] writes:

"On heating the mineral in a closed tube abundant water is easily given off and the mineral assumes a dark-olive color. On further heating it again becomes lighter in color. On heating the mineral in a crucible the color changes are very marked. At first the yellow mineral darkens and becomes a dark gray, then it becomes a light yellow, and on further heating changes to a deep orange color. If the mineral now be allowed to cool, the orange changes to yellow and back to orange again on reheating. If the dark-colored material be allowed to cool, it retains its dark gray color and on reheating passes through yellow to the orange. On heating for some time at a higher temperature, the mineral, on cooling, becomes a permanent bright green. By further heating all the molybdenum is volatilized and the dark-red ferric oxide remains. The mineral is readily soluble

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[1]Described by Horton, F. W., "Molybdenum: Its Ores and Their Concentration," Bu. of Mines Bull. 111 (1916).

[2]Bonardi, J. P., "Metallurgy of Wulfenite," CHEM. & MET. ENG., vol. 21, 1919, pp. 364-369.

[3]Haley, D. F., "Molybdenite Operations at Climax, Col.," Bull. A.I.M.E., August, 1918, p. 1183.

[4]Horton, F. W., "Molybdenum: Its Ores and Their Concentration," Bureau of Mines Bull. 111 (1916).

[5]Schaller, W. T., "Mineralogical Notes—Ser. 1," U. S. Geol. Survey Bull. 490, 1911, pp. 84-93; also *Am. J. Sci.*, 4, 23, 1906, p. 297.

in hydrochloric acid and is decomposed by ammonia. After awhile, all the molybdenum goes into solution, leaving the insoluble ferric hydroxide."

Qualitative and Quantitative Tests for Molybdite in the Presence of Molybdenite

The following chemical test for molybdite in presence of molybdenite has been tried out in the laboratory of the Golden Station of the U. S. Bureau of Mines, and has proved reliable for detecting molybdenum down to 0.01 per cent molybdenum on the basis of a 1-g. sample. A complete solution away from the sulphide mineral can be effectively made by one of the three following reagents: A 10 per cent solution of hydrochloric acid, a 10 per cent solution of ammonium hydroxide, or by a 5 to 10 per cent solution of sodium carbonate. The ore is ground fine, placed in an Erlenmeyer flask, 200 c.c. of water added and then enough of one of the above reagents to make a 10 per cent solution. This is then boiled for thirty minutes, filtered and washed. Before filtering the HCl solution it is made first ammoniacal to precipitate out the bulk of the iron. Any of these three methods of solution will completely dissolve the oxide of molybdenum in a boiling solution without affecting the sulphide to the least extent. This has been thoroughly tried out and has always given reliable results. Pure molybdenite was given the same treatment, but none was found in solution in any of the three cases.

The filtered solution of any one of the above filtrates is then tested for molybdenum by the thiocyanate test as follows: The filtrate if alkaline is acidified with HCl and some H_2O_2 added to oxidize any reduced iron or molybdenum that might have passed through into the filtrate. This is boiled to drive off most of the excess H_2O_2 and is then made ammoniacal. If any iron hydroxide separates out, filter and wash. To the filtrate, which is now free from iron, aluminum and silica, make acid with HCl, add some ammonium or potassium thiocyanate and immediately follow by zinc. If any molybdenum is present, a bright cherry-red color will develop which will disappear only on standing for a prolonged period, depending upon the amount of molybdenum present in the solution to be reduced. If hydrogen peroxide is added to the solution after the cherry-red color has developed, the color disappears, but will return as soon as the peroxide has been reduced. This color reaction with thiocyanate is very definite and certain, but if the mistake is made by adding the zinc first, which reduces the molybdenum, and then later followed by the thiocyanate, scarcely any color will be developed. When only traces or small amounts of molybdenum are present, a concentration of the cherry-red color can be obtained if the solution is shaken with a small volume of ether, when any color in the liquid will be extracted by the ether and intensified as a golden brown in the ether rings that form at the top of the liquid on standing. The thiocyanate color produced when iron is present in solution soon changes colorless, by the addition of zinc, usually before the cherry-red color of the molybdenum starts to develop.[6]

Weigh 5 to 10 grams of the finely pulverized molybdenite ore into a 400 c.c. Erlenmeyer flask. Add 200 c.c. water and then one of the following: 20 c.c. strong ammonia, 20 c.c. concentrated HCl, or 15 g. Na_2CO_3 and boil vigorously for 30 min. Wash the sides of the flask down with water, filter and wash. To the filtrate, if alkaline digestion was made, add HCl to acid, followed by a few c.c. of hydrogen peroxide and boil. Hydrogen peroxide is also added to the HCl filtrate; this oxidizes the iron which might have been carried in solution in a reduced condition. Next, add ammonia in excess and heat. If any precipitate settles out—consisting of iron, alumina and silica—filter and wash. If large in amount, dissolve in HCl and reprecipitate, wash and filter. The molybdenum now in the form of soluble molybdate should have a volume of approximately 350 c.c. Make the solution acid with HCl, using methyl orange as an indicator, adding about 5 c.c. excess of acid. Add 5 to 10 g. ammonium acetate—enough to decompose the free mineral acid—and 2 to 5 c.c. of acetic acid. The solution is next heated to boiling and precipitation of the molybdenum is now made in the hot solution by titrating the molybdenum content in the solution with a lead acetate solution (about 18 g. crystallized lead acetate per liter) added slowly from a burette until a test drop taken from the solution gives no color change with a drop of freshly made tannic acid solution (about 0.10 g. dissolved in 20 c.c. of water) used as an outside indicator. The disappearance of the brown color indicates when all the molybdenum has been removed from solution by precipitation. Next add 2 or 3 c.c. excess of the lead acetate solution and place the beaker back on the hot-plate and keep at or near the boiling point until the precipitate has crystallized and settled.

When settled, filter hot and wash well with hot water; if precipitate is bulky, wash with a 2 to 3 per cent solution of ammonium acetate. The washed filter is placed in a fireclay annealing cup and ignited at a dull red heat. After complete ignition of the paper, cool and weigh directly. The weight of the $PbMoO_4$ times 0.2615 gives the weight of the molybdenum in the precipitate, from which the percentage can be calculated.

The size of the sample taken for an analysis should be chosen if possible as not containing over 0.15 g. molybdenum (equivalent to 0.25 g. MoS_2), since above this amount the precipitated lead molybdate will be too bulky to handle to the best advantage. Hydrogen peroxide can not be added in the digestion of the sample along with the alkali or acid, since in combination with these reagents a chemical action will take place on the sulphide mineral, molybdenite, and render it appreciably soluble. A large excess of lead acetate should be avoided.

The following results are typical of an analysis carried out as outlined, showing the comparison of results as obtained by the three methods on the same sample of partly oxodized molybdenite ore containing a total of 5.2 per cent molybdenum, the molybdenum content being distributed in approximately the ratio of 1:1 between molybdite and molybdenite mineral.

Wt. of Sample, Grains	Treatment—½ Hr. of Boiling	Wt. $PbMoO_4$	Per Cent Mo
5	200 c.c. H_2O + 10 g. Na_2CO_3	0.4820	2.52
5	200 c.c. H_2O + 25 c.c. HCl	0.4770	2.49
5	200 c.c. H_2O + 30 c.c. NH_4OH	0.4800	2.51

The writer wishes to acknowledge the assistance rendered by Max Shapiro in conducting a series of analyses and to Dr. S. C. Lind, superintendent of the Golden station, who has made many valuable suggestions.

Three samples of pure molybdenite, on the same treatments, gave no test for molybdenum in the filtrates.

Golden, Col.

[6] Treadwell, F. P., and Hall, W. T., Analytical Chemistry, vol. I, 1912, pp. 437-438.
Kedesdy, E., "Detection of Molybdenum," *Chem. Abs.*, vol. 7, 1913, p. 3940.
Prescott, A. B., and Johnson, O. C., Qualitative Chemistry, 1912, p. 97.
Horton, F. W., citation 4, p. 40.

Synopsis of Recent Chemical & Metallurgical Literature

Resistance of Silk and Linen Fabrics to Weather Conditions and Ultraviolet Rays.—To determine the influence of changes in weather conditions and of ultraviolet rays on silk and linen fabrics, LEO VIGNON has conducted a series of experiments, the results of which he presented before the French Academy of Sciences (*Compte Rendus*, May 31, 1920, pp. 1,322-1,324).

The influence of changes in weather has been studied by submitting bands of silk and linen fabric (0.2 m. x 0.05 m.) during June and July, to these conditions:

(a) Sunlight. Bands stretched on wooden frames covered with window glass were exposed vertically to the sun's rays in a dry place from 10 a.m. to 4 p.m. for 45 consecutive days.

(b) Dry Heat. Bands dried for 20 min. at 100 deg. C. were quickly placed in a bottle containing dry calcium chloride and closed hermetically. The bottle was then kept heated in a drying stove to 60-65 deg. C. for 3 hr. per day for 45 consecutive days; during the remainder of each day the bottle was kept at atmospheric temperature and not submitted to the sun.

(c) Wet Heat. The test was similar to that for dry heat but instead of calcium chloride, the bottle contained a few c.c. of water.

(d) Moisture and Sunlight. Bands placed in a large bottle containing a little water were exposed to the sun from 12 noon to 6 p.m. for 45 consecutive days.

(e) Moisture and Diffused Light. The bottle containing the bands as in the previous test was kept in a closed place out of the sun for 45 consecutive days.

The results obtained are tabulated in Tables I and II.

TABLE I. ACTION OF THE WEATHER ON SILK FABRICS

Test	Resistance to Tearing Kg. per M.		Decrease per Cent	Final Aspect of the Fabrics
		Average		
Fabric used	1900–1920	1910	..	Grayish white
(a) Dry sunlight	1580–1600	1590	20	White
(b) Dry heat	1900	1900	0 5	No change
(c) Wet heat	1660–1680	1670	13	Somewhat yellowish
(d) Moisture and sunlight	1360	1360	30	Green and black moldiness, no odor
(e) Moisture and diffused light	1740–1760	1750	9	White moldiness, odor

TABLE II. ACTION OF THE WEATHER ON LINEN FABRICS

Test	Resistance to Tearing Kg. per M.		Decrease per Cent	Final Aspect of the Fabrics
		Average		
Fabric used	1540–1560	1550	..	Grayish white
(a) Dry sunlight	1280–1300	1290	20	White
(b) Dry heat	1380	1380	12	No change
(c) Wet heat	1300–1340	1320	15	Somewhat yellowish
(d) Moisture and sunlight	1060–1100	1080	31	No change
(e) Moisture and diffused light	440– 560	500	68	Abundant green and white moldiness, strong odor

The influence of ultraviolet rays has been studied with 0.17 m. x 0.05 m. bands placed at a distance of 0.1 m. from a Heraeus lamp. To eliminate the action of the ozone which is formed around the lamp the tests were performed near an open window to have an atmosphere with small quantities of ozone. The temperature of the band was around 25 deg. C. The results obtained are given in Table III.

TABLE III. ACTION OF ULTRAVIOLET RAYS ON SILK AND LINEN FABRICS

Fabrics	Silk		Linen	
	Resistance to Tearing, Kg. per M.	Decrease, per Cent	Resistance to Tearing, Kg. per M.	Decrease per Cent
Before exposure	1,600	...	1,800	...
After 24-hr. exposure (0.1 m. from lamp)	1,300	20	580	68
Before exposure	1,540	..	1,780	...
After 48-hr. exposure (0.1 m. from lamp)	925	40	Below 200	Above 89
Before exposure	1,520	...	1,780	...
After 96-hr. exposure (0.1 m. from lamp)	817	48	Below 200	Above 89
Before exposure	1,660	...	1,840	...
After 72-hr. exposure (0.3 m. from lamp)	1,470	17	1,520	18

The conclusions arrived at are that fabrics of animal origin (silk) are more resistant than those of vegetable origin (linen) to the influences of weather and ultraviolet rays. This can be explained by the fact that albuminoid molecules resist hydrolysis better than the cellulose molecules.

Elutriation Tests of American Kaolins.—The May, 1920, issue of the *Journal* of the American Ceramic Society prints an original paper by H. G. SCHURECHT of the Bureau of Mines on this important subject.

The classification of clays according to grain size is important because many physical properties are to a limited degree functions of the size of grain. A more complete knowledge of the fineness of grain of our domestic kaolins would be valuable in determining American substitutes for foreign clays. The paper contains a complete record of the tests with tables. Chemical analyses, microscopic examination, sieve analyses, and elutriation or washing analyses were all carried out, and determinations were made as to relation between velocity of flow and diameter of particles. Tap water was compared with distilled water in the elutriation tests. The writer sums up the results of his extensive work as follows:

The elutriation of kaolins should be carried on with distilled water instead of tap water, as the soluble salts in tap water cause the clay particles to coagulate and settle as larger grains.

The residue in each can should be thoroughly stirred each day to overcome the error due to settling of fine particles on the sides of the cone. This may be done by stopping the water flow and gently blowing air through the stem of the thistle tubes. Each sample should be elutriated for at least three days to insure a complete separation or until the overflow from the last can is clear.

Results check more closely when the residues are stirred at intervals and when distilled water is used in place of tap water.

The clays should be deflocculated and fed into the elutriator drop by drop, and during this period the velocity of the flow should remain about one-third below maximum.

It was found that the Georgia, South Carolina and Pennsylvania kaolins tested in this investigation contain a high per cent of clay-like substance below 0.010 mm., comparing favorably with the English china clay in this respect.

The North Carolina kaolins tested showed a comparatively low per cent of fine or clay-like substance.

English ball clay contains an extremely high per cent of fine material, 98.55 per cent being carried away by a flow of 0.0197 mm. per sec. Only 40.75 per cent of English kaolin was carried off by this velocity. It is evident that the greater plasticity and bonding strength of ball clays, as compared to kaolins, is due largely to their finer grains.

The observed diameters of the particles, as separated with distilled water, correspond reasonably closely to the calculated results obtained by using Schone's empirical formula.

Properties and Uses of Lime.—General Information of interest to chemists and chemical engineers on the properties and uses of lime will be found in the second edition of Bureau of Standards Circular 30.

Lime is made by heating limestone under certain conditions, whereby it is decomposed into an escaping gas, carbon dioxide, and a non-volatile residue, lime or quicklime. This lime, when treated with water, hydrates, or slakes. If water is used in great excess, a paste results; but if the amount is properly regulated, the hydration yields a dry powder, which is called hydrated lime. Since natural limestones contain more or less magnesia, iron, silica, etc., the quality of the lime will depend to some extent upon the nature and amount of these foreign materials. It will also depend upon the way in which the stone is burned.

As a material for building construction, hydrated lime is better adapted than quicklime because it eliminates the labor usually required to do the slaking. It is used very largely as a brick mortar, as an ingredient in concrete, and in the scratch and brown coats of plaster. A particular grade of hydrated lime, noted for its plasticity, is sold as finishing lime and is used for the white coat of plaster.

Limestone, quicklime, and hydrated lime are used to a large extent as chemical reagents in the manufacture of other materials. In some of these industries the quality of the lime is of minor importance. In others, the use of only one of the three forms of lime is satisfactory, and the quantity and kind of impurity which the lime may contain is definitely specified.

Eighteen of the most important chemical industries that use lime are enumerated. Brief descriptions of these industries are given, showing why and how they use lime, and the quality of lime which they require.

A list of the tests of lime which are usually made includes chemical analysis, rate of hydration, plasticity, sand carrying capacity, time of set, compressive strength, proportion of waste, and fineness.

Inks.—The Bureau of Standards has recently issued Circular 95, giving general information on the subject of inks. The composition and manufacture are discussed only briefly, but the methods of testing which are in use at the Bureau of Standards are given in sufficient detail to enable any chemist to use them. After a brief introduction on the history of ink, there are discussions of writing and copying inks, ink tablets and powders, marking, canceling, stamping, duplicating and sympathetic inks. The methods used for the laboratory examination of all but the last of these kinds of ink are next taken up. Under the analysis of writing inks, for instance, are the following headings: Total solids, ash, iron, sulphuric anhydride, tannin, dye, chromium, penetration, fluidity, keeping quality and resistance to light and reagents. For the other kinds of ink there is not such a variety of tests necessary. The circular closes with a short bibliography.

Recent Chemical & Metallurgical Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Removal of Sodium Sulphate From Solutions.—Sodium sulphate may be removed from solutions which are saturated or nearly saturated in respect to this salt by treating with a quantity of calcium sulphate sufficient to form the double salt $CaSO_4Na_2SO_4$ commonly known as glauberite. The double salt is removed by filtration and digested with sufficient water to break it up into a mixture of solid $CaSO_4$ and a solution of Na_2SO_4. (1,343,443; F. A. FREETH, of Sandiway, and H. E. COCKSEDGE, of London, England; June 15, 1920.)

Chrome Alum.—Ferrochrome when ground to a fine powder dissolves in sulphuric acid, the solution being complete in two to three days when working on a manufacturing scale. The presence of lead accelerates the solution of the ferrochrome. The resulting solution is treated with potassium chloride or sulphate and the chrome alum crystallized out. Prior to the addition of the potassium salt, the iron content of the solution may be reduced about one-half by crystallizing out ferrous sulphate. (1,343,725; GUSTAF H. HULTMAN, of Stockholm, Sweden; June 15, 1920.)

Manganese Dioxide Depolarizer.—When manganese carbonate (prepared by the interaction of solutions of manganese sulphate and sodium carbonate) is subjected to an oxidizing roast at 325 to 425 deg. C., manganese dioxide is formed according to the equation:

$$2MnCO_3 + O_2 = 2MnO_2 + 2CO_2$$

This reaction is accelerated by the presence of chlorides or chlorine containing materials in the roast. Thus the addition of ½ to 8 per cent sodium chloride greatly decreases the time and temperature required for roasting. (1,343,390; HAROLD C. CHAPIN, of Cleveland, Ohio, assignor to National Carbon Co.; June 15, 1920.)

Ammonium Perchlorate From Sodium Perchlorate and Ammonium Sulphate.—A nucleus solution is prepared at 100 deg. C. to contain 12.2 per cent ammonium perchlorate, 6 per cent sodium perchlorate and 15.5 per cent sodium sulphate. To this solution is then added the proper amounts of sodium perchlorate and ammonium sulphate, to produce a solution containing 32.5 per cent ammonium perchlorate, 5.5 per cent sodium perchlorate and 12 per cent sodium sulphate, and the anhydrous sodium sulphate which separates at this temperature is removed. The filtrate is diluted with a quantity of water so that, when cooled to 20 deg. C., the resulting solution will contain 11.7 per cent ammonium perchlorate, 6.8 per cent sodium perchlorate and 14.9 per cent sodium sulphate. The solution is then cooled to the above-mentioned temperature and the pure ammonium perchlorate removed. The mother liquid from the ammonium perchlorate is concentrated by evaporation until it has the same concentration of dissolved salts as the original nucleus solution. (1,342,956; GUY C. GIVEN, HOWARD S. MCQUAID and RALPH A. LONG of Tamaqua, Pa., assignors to Atlas Powder Co.; June 8, 1920.)

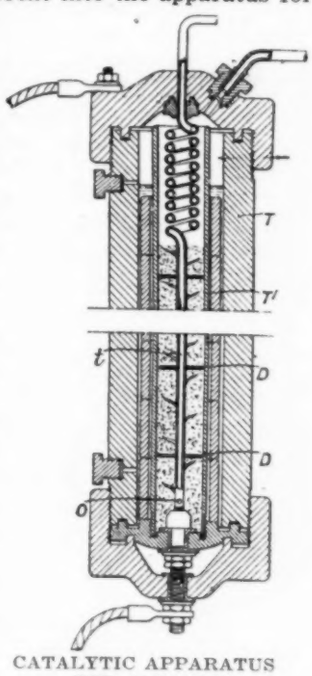
Removal of Nickel From Zinc Sulphate Solutions.—H. L. SULMAN and SAMUEL FIELD, of London, England, first remove by usual methods such metals electro-negative to zinc as iron, arsenic, antimony, copper and cadmium; this solution freed from these metals is treated with finely divided zinc dust at a temperature of 80 to 100 deg. C. The nickel remaining in solution after this treatment is less than one part per million. (1,341,601; assigned to the Metals Extraction Corp., Ltd.; May 25, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Effecting Reactions at High Pressure and at High Temperatures. — In carrying out reactions at high temperatures—for example, the synthesis of ammonia—it is necessary to protect the outer pressure-sustaining wall of the apparatus—for example, by interposing a layer of liquid, such as fused potash-soda mixture—that is stable, inert and a poor conductor of heat. According to the present invention, movement of the liquid such as would vitiate its protective action is prevented by a filling consisting of a pile of rings of a material that is a poor conductor of heat and has the property of removing any hydrogen, if this is one of the reacting-gases, dissolved by the liquid; such a material is magnetic oxide of iron. (Br. Pat. 140,083—1919. L'AIR LIQUIDE, SOC. ANON. POUR L'ETUDE ET L'EXPLOITATION DES PROCÉDÉS. G. CLAUDE, Paris, May 12, 1920.)

Catalytic Apparatus for Ammonia. — In apparatus for effecting exothermic reactions in gases, the latter are led to a mass of catalyst through a tube which also serves to convey electric current into the apparatus for starting or promoting the reaction; preferably, the tube itself acts as the heating element and it may also serve as a heat interchanger between the products of the reaction and the incoming gas. The invention relates particularly to apparatus for use in the synthesis of ammonia. In the apparatus shown, the reaction tube T', containing the catalyst, is enclosed in a pressure-sustaining tube T, and the latter is protected by molten material in which is immersed heat-insulating material. The reaction gases are led in through the tube t which forms the heating-element and is provided with a series of bars to support the catalyst and with earthenware or china disks D to obviate short-circuiting; the gases pass through the whole length of the tube and escape through an opening O at its lower end. In the free space above the catalyst the tube is coiled to provide a heat interchanger, and to prevent undue rise in temperature this part of the tube is thicker and of a better conductor, or the spirals are short-circuited. In use, a heavy current of low voltage is passed through the tube in order to produce a temperature gradient between the reaction-tube and the outer wall T comparable with that obtaining during the normal working of the apparatus; by this, the protective material is fused regularly, and overdue strains on the tube T are obviated. (Br. Pat. 140,089 — 1919. L'AIR LIQUIDE, SOC. ANON. POUR L'ETUDE ET L'EXPLOTATION DES PROCÉDÉS. G. CLAUDE, Paris, May 12, 1920.)



CATALYTIC APPARATUS FOR AMMONIA

Tanning. — To accelerate tanning processes, compressed or liquid air, or oxygen in a more or less compressed state, is brought into contact with the hides. The hides to be tanned are placed in closed pits into which there is admitted either pure water or water containing tanning substances and air or oxygen compressed more or less strongly according to the nature of the hides. The closed pits containing the hides may be supplied from a central pit, the liquid being in constant circulation and, if necessary, filtered on leaving the central pit. (Br. Pat. 140,092—1919. TANNAGE RATIONNEL MEURANT, SOC. ANON., Liége, Belgium, May 12, 1920.)

Electrolytic Production of Alcohols, Glycols, Ethers, Hydrocarbons and Oxygen.—Aldehyde or paraldehyde, derived from acetylene, is electrolytically reduced to alcohol or ethyl acetate. An acid electrolyte is employed, such as sulphuric acid of 5 to 10 per cent strength, or a solution of sodium bisulphate, phosphoric acid or an organic sulphonic acid. If a mercury compound is added, acetylene may be passed directly into the liquid instead of being separately converted into aldehyde. In the production of alcohol, anode oxidation is prevented by a diaphragm, but for ethyl acetate, the diaphragm is omitted or an inefficient one employed. The cathode may be of lead, pure or antimoniated, and optionally amalgamated or electroplated with lead; or a body of mercury may be used. Suitable materials for the anode are platinum, lead, oxide of iron, carbon and graphite. The last two impart an agreeable bouquet to the alcohol. When alcohol is to be produced, a cathode density of 2 to 3 amp. per sq.dm. is employed, and the temperature is not allowed to rise much above 40 deg. C. About 10 per cent of aldehyde is initially added to the electrolyte; a subsequent addition may raise the proportion of organic substance above 30 per cent. If the temperature, concentration of acid or aldehyde, current density, or duration of treatment is increased, byproducts are obtained, such as 1 to 3 butane-diol, crotonyl alcohol, butyl alcohol, and ethyl ether. Catalytic dehydration of the first or second of these gives butadiene. Oxygen, with or without ozone, is evolved at the anode, and may be utilized for metal-working, purification of waste waters and sewage, or oxidation of nitrous vapors. (Br. Pat. 140,115—1919. P. V. H. PASCAL, Angouléme, France, May 12, 1920. See also Pat. 148,527—1919, May 19, 1920).

Catalytic Hydrogenation. — An aluminate of a heavy metal such as nickel is used as the catalyst in the hydrogenation of unsaturated organic compounds such as fatty acids and their esters. The catalyst is prepared, for example, by mixing solutions of nickel sulphate and sodium aluminate, washing the precipitated nickel aluminate, and afterward treating the dried aluminate at a temperature of 300 to 400 deg. C. with a current of hydrogen. The aluminate may be precipitated in an inert carrier such as kieselguhr. (Br. Pat. 140,371—1919. NORDISKE FABRIKER DE-NO-FA. AKTIESELSKAP, Christiania, May 12, 1920.)

Third Meeting, International Union of Pure and Applied Chemistry

THE third meeting of the International Union of Pure and Applied Chemistry was held in Rome June 22 to 25, under the presidency of Prof. Charles Moureu, member of the Institut de France. There were present representatives of Belgium, France, Great Britain, Italy and the United States, the five countries which founded the Union. (See CHEM & MET., vol. 21, pp. 234, 424.) Seven new countries were admitted unanimously; they are: Canada, Denmark, Spain, Greece, Holland, Poland and Czechoslovakia.

The following were the delegates to the general assembly:

For Belgium: Frédéric Swarts, professor at the University of Gand, and Dr. René Lucion, former president of the Société de Chimie de Belgique.

For Denmark: Einar Billman, professor of chemistry of the University of Copenhagen, and M. Warming.

For France: Prof. G. Bertrand, president of the Société Chimique de France; F. Bordas, professor at the Collège de France; Jean Gérard, general secretary of the Union Internationale de la Chimie; Paul Kestner, president of the Société de Chimie Industrielle; Prof. L. Lindet, member of the Institut de France; Ch. Lormand, chemist at the French Department of Agriculture; Camille Matignon, professor at the Collège de France, vice-president of the Société de Chimie Industrielle; Ch. Marie, general secretary of the Société de Chimie Physique; Prof. Charles Moureu, president of the Union Internationale de la Chimie, and M. Nicolardot, of the Paris Ecole Polytechnique.

For Great Britain: Sir William Pope, professor at Cambridge University, president of the Society of Chemical Industry, and Mr. Hay, technical delegate of the Reparation Commission.

For Greece: M. Zenghelis, professor at the University of Athens.

For Italy: G. Bruni, professor at the Polytechnic of Milan; Senator C. Ciamician, professor at the University of Bologna, president of the Associazione Italiana di Chimica generale ed applicata; F. Garelli, professor at the Polytechnic of Turin; R. Nasini, professor at the University of Pisa; L. Parodi-Delfino, vice-president of the Associazione Italiana di Chimica generale ed applicata; G. Oddo, professor at the University of Palermo; M. Plancher, professor at the University of Parma; Senator E. Paterno, professor at the University of Rome, president of the Consiglio Nazionale di Chimica; F. Quartieri, administrator of the Societa Italiana Prodotti Esplodenti, and A. Peratoner, professor at the University of Rome.

For Holland: R. H. Kruyt, professor of physical chemistry at the University of Utrecht, president of the Nederlandsche Chemische Vereeniging.

For Poland: M. Kowalski, professor at the Polytechnic of Warsaw.

For Czechoslovakia: E. Votocek, professor at the Polytechnic of Prague, president of the Bohemian Chemical Society.

For the United States: Dr. Charles L. Parsons, general secretary of the American Chemical Society.

The meeting took place at the Corsini Palace, Academia Nationale dei Lincei.

Mr. Nicolardot spoke on the needs for standardizing the methods of chemical analyses for foods and proposed the establishment at Paris of a permanent international bureau with this aim in view.

Mr. Crismer presented the report on the creation of an international institute of chemical standards. It was voted to organize such a bureau, which shall comprise three divisions, namely: chemical standards, standards for pure products used in research work, and standards for technical products.

Mr. Matignon read a report on the importance of thermochemical data and proposed the creation of a commission composed of specialists of the different countries, members of the Union, to prepare and submit a project for the establishment of thermochemical standards.

Mr. Trincheri spoke on the juridic value of sealed letters in the applications for patents, and the following motion was adopted after lengthy discussion:

> The International Union of Pure and Applied Chemistry shall constitute a commission composed of members competent in the technical and juridic aspects of the problems relating to patents, and the first problems to be studied shall be the juridic value of the sealed letters and the creation of an international patent.

It was also voted that Italy shall prepare the project for such an organization.

INTERNATIONAL COMMISSION OF ATOMIC WEIGHTS CREATED

The study of the report of W. D. Bancroft, chairman of the Division of Chemistry and Chemical Technology of the U. S. National Research Council, on the International Commission of Atomic Weights, resulted in the creation of an international commission of atomic weights. The members proposed for this commission are Messrs. Clarke, Thorpe and Urbain.

Prof. Oddo presented a motion that the revision of the table of atomic weights shall be decennial and to take the atomic weight H = 1 as the basis of the system.

Mr. Marie made the motion that the International Committee of the Tables of Constants shall be included in the Union. This was approved.

To make the work of the conference more useful and to attract the attention of the respective governments on the importance of the work of the Union, the following motion was adopted at the request of the Danish delegation:

> The International Union of Pure and Applied Chemistry hopes that all the delegates of the nations members of the Union will try to have their countries recognize the work of the Union as of public utility.

The Union will present to the Italian Government the proceedings of the conference *in extenso* with the request that they shall be communicated officially to the governments of all the participating countries.

In closing the meeting it was decided to accept the invitation of the Polish Government to hold the 1921 meeting in Warsaw.

Laboratory for Low Temperature Work to Be Established

A cryogenic laboratory is to be established at once in Washington in connection with the helium work being done by the Bureau of Mines. The necessary funds for equipping the laboratory and conducting the work are being allotted to the Bureau of Mines from appropriations made to the Army and Navy Departments. The work in this new laboratory will be directed by R. B. Moore, the chief chemist of the Bureau of Mines.

Current Events
in the Chemical and Metallurgical Industries

Dye Division of the American Chemical Society

The Dye Division of the A. C. S., which had its inception first as a Dye Symposium, then as a Dye Section, is now a duly organized part of the American Chemical Society. The division is undertaking to carry on regular and systematic work for the benefit of the dye industry of America in general, and the users of dyes, manufacturers of dyes, and dye chemists in particular, laying, of course, especial emphasis upon the chemistry of dyes and dyeing.

It is the duty and the privilege of every chemist in America who is interested in the chemistry, manufacture or use of dyes to enroll himself as a member of the American Chemical Society and of its Dye Division, to attend and to participate in the semi-annual meetings. The advantage will be mutual, both to the members and to the industry.

It is planned, as soon as funds permit, to compile and distribute a directory of dye chemists who are registered in the Dye Division of the A. C. S. Further information may be obtained from the secretary, R. Norris Shreve, 43 Fifth Ave., New York City.

High-Grade Silica for Los Angeles

Another forward step has been taken by southern California ceramic interests in the opening of the new $100,000 plant of the Western Silica Co. at 2300 East 52d St., Los Angeles. With an initial output of thirty-five tons of washed silica per day, an amount which will soon be increased, this plant assures the development of the large deposits of high-grade silica in Antelope Valley, and assures for the industry a local supply of a product which has formerly had to be shipped from Illinois to the Coast. The silica from portions of these deposits runs over 99 per cent in purity, and is suitable for the highest grade of glass and ceramics. Charles E. Kaltenbach of Newark, N. J., a well-known silk goods manufacturer, is backing the new company, and Telfair Creighton is superintendent.

American Concern to Manufacture Ichthyol

The drug ammonium sulpho-ichthyolate, manufactured by the Meadows Oil & Chemical Corp. from an American fossiliferous marine deposit, is soon to appear on the market. Its germicidal action against *Staphylococcus py. au.* and *B. coli* is identical with the German product, but its penetration, particularly in high dilution, is from 200 to 400 per cent greater, and its therapeutic value has been found to be far superior.

Holyoke Mills Close for Repairs

The annual shut-down of the Holyoke mills began Saturday, July 31. The closing period was five days for the paper mills, and ten days for the balance of the factories. This closing is for the purpose of making necessary repairs to the canals. The paper mills will hardly regard it as an unmixed evil at this time, as it will enable them to accumulate at least a small reserve of pulp.

Importance of Italy's Water Power

Samuel M. Vauclain, president of the Baldwin Locomotive Co., on returning from a long business trip through Europe, declared that conditions in the countries he had visited were quite different from what is generally believed in America, and the rapidity with which those countries return to normal conditions would be according to the credit which they are able to obtain from abroad.

Conditions in Italy are better than in other countries. In fact, Italians are already producing and selling their products. If they could get better railway transportation they might even increase their export business, but they are handicapped by the lack of coal.

Despite this, however, due to its hydro-electric developments, Italy possesses some industries which can compete with the most important of those nations more favorably situated.

Several prominent manufacturers, realizing the seriousness of the coal situation, have rapidly substituted hydro-electric power. Among them was the Fiat Motor Works, which obtained control of the Mont Cenis Hydraulic Power Co. and can now generate 200,000,000 kw. throughout the year.

It is interesting also to note that the Italian Government has taken steps to electrify more than 6,000 km. of railway so as to reduce to a minimum the use of coal. Heat power being substituted by water power, coal consumption will be reduced by more than one-third. Thus in the very near future, when Italy will be able to utilize all the water resources so lavishly provided by nature, she will have solved one of the hardest problems which most European nations are now facing with great anxiety.

New Pulp and Paper Mill for Fort William, Ontario

Preliminary work has just begun on the plant for the new pulp and paper mill in Fort William, Ont. Its name is the Fort William Pulp & Paper Co. (Ltd.). It is said that the plant will cost about $3,000,000, and when in full operation will employ 1,000 men and turn out approximately 100 tons of pulp daily. The raw product will be obtained from the nearby forests, and the necessary power will come from Kakabeka Falls, about twenty miles distant.

Judgment Affirmed Against Chemical Companies

In the two actions brought by Joseph and Catherine Stellwagon against the S. Wander & Sons' Chemical Co., Inc., the Appellate Division of the New York Supreme Court, Fourth Department, has affirmed judgment against the Chemical company.

In the case of the Walker M. Levett Co. against the British Aluminum Co. judgment for the former was appealed from by the latter, but the Appellate Division of the New York Supreme Court has affirmed judgment against the Aluminum company.

Organization Plan of the Federal Power Commission

The plan of organization of the Federal Power Commission was worked out at a meeting of the commission in Washington July 27. The work of the commission is to be divided into the following activities: Engineering, accounting, statistical, regulatory, licensing, legal, operation. The engineering division is regarded as the most important, as it must make: General investigation of the electric power industry; general investigation of water-power sites and estimates on cost of development; estimates of amount and value of power available at Government dams; examinations, cost estimates and reports to Congress on projects recommended for construction by the United States; examinations and reports to Congress on projects for which it is recommended that the cost of navigation facilities be supplied in whole or in part by the United States; preparation of plans for development of streams and stream systems upon which applications for licenses are made; construction plans proposed by licensees; physical valuation of properties in rate-making proceedings and when existing plants are brought under the act; determination of necessary repairs required for maintaining projects in effective operating condition; determination of adequate depreciation reserves upon properties; determination of operating rules necessary for protection of life, health and property.

The immediate direction of the engineering activities will be under the engineer officer, who will act as chief engineer of the commission.

For convenience in administering the act the country has been divided into five districts. The headquarters of these districts will be in Washington, St. Paul, St. Louis, Denver and San Francisco. Branch offices will be maintained in each of those cities at which notifications may be made and announcements given out.

Interstate Commerce Commission Issues New Coal Order

The issuance of a second New England coal order by the Interstate Commerce Commission, which repeals order No. 6, issued June 19, is expected to relieve the coal shortage in that section of the country. The experience with the former order enabled the operators and the railroads to determine accurately just what had to be done to move the tonnage necessary to insure an adequate supply for the northeastern group of states.

The new order places a single agent in charge of all tidewater facilities at Hampton Roads. The exact tonnage which must be moved each month is allotted to each of the tidewater railroads serving coal fields.

The railroads promise to supply sufficient cars at all mines assisting in furnishing the New England tonnage, to make maximum production possible. If this is done there will be enough coal left after the New England allotment is furnished to supply their other customers.

There is no disputing that the President two weeks ago was seriously considering the appointment of a Fuel Administrator and the restoration of governmental control over the coal industry. The harmonious way in which the operators and the carriers worked out the plan provided in the new New England order is said to have satisfied the White House that the situation will be met.

Factors Contributing to Anhydrous Ammonia Shortage

Despite some improvement in the transportation situation the shortage of anhydrous ammonia remains acute. Additional information gathered by Government specialists shows that the following factors are contributing to this shortage: The increased demand for anhydrous ammonia for refrigeration purposes; overproduction of ammonia cylinders; diversion of some of the ammonia liquor to make ammonium sulphate; the coal strike, which cut down the production of ammonia liquor; the switchmen's strike, with its resulting embargoes, which has caused slow movement to the consumer and has delayed the return of cylinders for refilling.

An important factor in increasing the amount of refrigeration at this time is the unusually large amount of meat which is being held in storage. Europe is producing more meat and other food products. This has enabled the Europeans to diversify their diet and the consequence is smaller purchases of American meat. A great deal of South American meat has been brought in and it, too, must be held in storage.

Following the armistice many coking plants closed, which reduced the production of ammonia liquor. Production was curtailed further by the influence exerted by the action of the Government in throwing 100,000 tons of ammonium sulphate on the market. It will be recalled that ammonium sulphate sold for pre-war prices for six months after the signing of the armistice. The farmers of both this country and England, however, had been educated during the war to use ammonium sulphate instead of sodium nitrate for fertilizing. This contributed largely to the rapid increase in the demand for sulphate. The attractive prices for sulphate are thought to have stimulated the making of sulphate in preference to anhydrous ammonia. It appears that the situation was not anticipated and sufficient retorts are not available for the liming of sulphate and the consequent production of anhydrous ammonia.

Artificial Silk Plant to Be Erected Near Buffalo

The du Pont Fibersilk Co., a company recently incorporated for the manufacture of artificial silk, has purchased a plant site of 100 acres on the shores of the Niagara River. The factory is to have 200,000 sq.ft. floor space and will employ about 700 persons. Active work on the plant is expected to commence some time in the spring.

This company was formed as the result of an agreement between E. I. du Pont de Nemours & Co. and the Comptoir des Textiles Artificiel of Paris, France, a company which controls practically all of the largest artificial silk plants of Europe.

Decision Delayed as to Site of Non-Metals Experiment Station

Matters have arisen which will delay the final decision as to the location of the non-metals experiment station of the Bureau of Mines. Dorsey A. Lyon, the Bureau's supervisor of stations, and R. B. Moore, its chief chemist, have submitted a report to Dr. Cottrell, the director of the Bureau, setting forth the advantages and the disadvantages of each of the localities under consideration. It may be that Dr. Cottrell will visit some of the proposed sites before making his decision.

Papers to Be Read at T.A.P.P.I. Meeting

In addition to the program published in our issue of July 28, page 167, the following papers of technical interest will be read and discussed:

Quick Method of Determining the Presence of Sulphate Fiber in Paper, by R. E. Lofton and H. F. Merritt.

New Felt Cleaning Device as a Means of Increasing Production, by C. A. Woodcock.

Boiler Room Efficiency Increased by a new Mercury Boiler, by W. L. R. Emmett.

A Continuous Mixing System for Newsprint Mills, by C. N. Allen.

Automatic Cooking Control for Sulphite Digesters, by E. J. Trimbey.

Preliminary Report for a New Method of Testing Lime and Cement Bags, by P. L. Houston.

Curtailing Bleach Consumption by Adding Sulphur to Digester Liquor, by George K. Spence.

Discussion of Substitutes for Alum and Rosin in Sizing Papers, led by W. E. Byron Baker and Max Cline.

It is of the utmost importance that the chairman of the local committee of arrangements, Charles F. Rhodes, International Paper Co., Glens Falls, N. Y., be notified, by means of reply postal cards sent previously, of members' intention to attend the fall meeting, it being necessary to arrange in advance for transportation for mill visitations, as well as luncheons, dinners, etc.

Members are again reminded of the necessity of making individual requests for room accommodations at hotel headquarters, Grand Union Hotel, Saratoga Springs, N. Y.

New Cold-Storage Plant at Liverpool

Consul Horace Lee Washington reports from Liverpool, England, that a cold-storage plant, claimed to be the largest and most up to date in Europe, is nearing completion at the Alexandria Dock, Liverpool, constructed by the Union Cold Storage Co. The first section of the plant, opened in August last, has a capacity sufficient for the storage of 11,000 tons of foodstuffs. When completed the total cubic capacity will be over 3,000,000 ft. and the accommodation will approximate 30,000 tons of eatables, including meat, fish, poultry, game, eggs, butter and cheese. The equipment will be the most modern obtainable. In order to avoid exposure of meat in transport from ship to the plant the adjacent dock sheds have been fitted with a system of conveyors which enables the meat to be picked up at any point and conveyed under direct cover to the plant, thus avoiding any break in refrigeration. The building is in direct railway communication with the main railway systems of the country.

New Lubricant Company

The Graphite Oils Co. (Ltd.) recently offered for public subscription 150,000 shares of £1 each to take over the going concern called Graphite Oils (Ltd.), of Glasgow. Fifty thousand shares (making the total capital £200,000) were issued in part payment of the purchase price to the vendor company.

According to the prospectus, the vendor company was established in 1913 to test and develop the discovery of a method for the manufacture of lubricating oils and greases with natural graphite in suspension therein. The uses of graphite as a lubricant, the prospectus remarks, were formerly limited, "because the engineer could not find a means whereby it could be held in suspension in oil, and so could be carried with the oil into the internal workings of engines and bearings," but the process employed by the company has now rendered this possible.

Book Reviews

NON-TECHNICAL CHATS ON IRON AND STEEL AND THEIR APPLICATION TO MODERN INDUSTRY. By *Le Vergne W. Spring*, chief chemist and metallurgist of the Crane Co., Chicago. New York: Frederick A. Stokes Co. 358 pp., 294 illustrations and diagrams.

This book is a collection of articles by Mr. Spring which appeared in the Crane Co.'s house organ called the *Valve World*, so arranged as to give a comprehensive series of popular talks on iron and steel from a scientific standpoint. It is interesting from cover to cover; written in an entertaining and agreeable style, and contains a great deal of information that the user of steel and the intelligent layman should know.

The work properly begins with an early history of iron; then the raw materials are considered, then the blast furnace, and following this comes a chapter called "A General Glimpse Ahead." This has less to do with the future development of the industry than with a survey of the many varieties of iron and steel now known and in use. It is a glimpse ahead for a pig of iron.

It is fair to say that the science of ferrometallurgy, as representative of the organization and arrangement of particles in ferrous alloys, is still too undeveloped to make explanations or even guessing easy. For this reason, and with no reflections on Mr. Spring, we wish the book were better than it is. We haven't got beyond the stage of rather messy thinking in regard to the philosophy of iron and steel, and we can hardly expect to get out of it until we know more than we do. What is most needed is research in pure chemistry without any thought of utilities. Here is a great field.

The author is not speculative and he does not point out what may be done at some future date. It is feared that with the death of Joseph E. Johnson, Jr., a great deal of valuable research on the behavior of iron ore when smelted with oxygen in the place of air has been lost. It is known that too much iron vaporized in his tests, but he believed that he was on the road to illuminating information and possibly to marked economies, but, as he told the reviewer a few weeks before he was run over and killed by an automobile, he was "not yet ready" to publish.

After Mr. Spring's "Glimpse Ahead" there follow chapters on Wrought Iron, Cementation and Crucible Steels, Bessemer Steel, Open-Hearth Process, Cast Iron, Malleable Cast Iron, Alloy Steels, High-Speed Steels, Mechanical Treatments, Rolling, Rolling Rods, Wire and Wire Drawing, Pipe and Tubes, Seamless Steel Tubes and Transformations and Structures of the Steels. This last was a hard chapter, and, considering the little real information that we have in comparison to the sum total yet to be discovered, it was well done. The book closes with an equilibrium diagram of iron-carbon alloys.

In treating such a big subject within a limited space it is possible, of course, to think up a great variety of important features of the subject that might have been treated which are either merely mentioned or that have not been discussed at all. But on the whole I think Mr. Spring is to be congratulated on writing in popular form (which takes more space by far than technical writing) a great deal of useful information in relation to his subject. An intelligent foreman in a machine shop, a steel mill or a foundry is likely to be a more intelligent foreman after he has read it. ELLWOOD HENDRICK.

Personal

HOWARD C. ADAMS, formerly chief estimator for Tate-Jones & Co., Inc., has joined the George J. Hagan Co. of Pittsburgh, as engineer in its liquid fuel department.

CHARLES H. BREED, until recently metallurgist with the Brown Cork & Seal Co., of Baltimore, has joined the staff of Daniel M. Luehrs, industrial consulting engineer, Cleveland, Ohio, as consulting metallurgist in charge of the metallurgical laboratories.

EDWARD B. ELLICOTT, recently Colonel in the Chemical Warfare Service, has become associated with A. M. Castle & Co., iron and steel merchants, Chicago, in the capacity of chief engineer.

Dr. CHARLES H. FULTON, professor of metallurgy of the Case School of Applied Science, has resigned to become head of the department of mining engineering at the Missouri School of Mines, Rolla, Mo.

LLOYD HALL has accepted a position with the Boyer Chemical Laboratory Co. as research chemist in charge. He was formerly connected with the Chemical Warfare Service.

E. H. HEUMANN, until recently connected with the chemical department of the Crown Cork & Seal Co., Baltimore, Md., has joined the staff of Daniel M. Luehrs, industrial consulting engineer, Cleveland, Ohio, as chemist in charge of the chemical laboratories.

EUGENE F. HICKSON has resigned his position as first assistant chemist in the paint and varnish section of the Bureau of Standards to accept a position as associate engineer in the department of technical control of the American Writing Paper Co., Holyoke, Mass.

WALTER R. KIRNER is now associated with the synthetic chemistry department of the Eastman Kodak Co.'s research laboratory. Mr. Kirner was Lieutenant in the Chemical Warfare Service.

L. D. LE FORGE of the Bureau of Chemistry, Department of Agriculture, gave a talk recently before the Chicago Chemists' Club on corncob products. He exhibited some samples of paper, glue, woodstuffs and cellulose made from corncobs. He is co-operating with the Forest Products Laboratory, Madison, Wis., on paper manufacture.

Dr. R. B. MOORE, chief chemist of the Bureau of Mines, is in Golden, Col., assisting in the winding up of the affairs of the Bureau of Mines station, which is to be moved to Reno. Before his return to Washington he will visit Reno and the United States helium laboratory at Petrolia, Tex.

H. B. NORTHRUP, who has been associate professor of metallurgy at the Pennsylvania State College, State College, Pa., for nine years, has resigned to become chief metallurgist of the Diamond Chain & Manufacturing Co., Indianapolis, Ind.

ALFRED M. STAEHLE, formerly editor of the *Blast Furnace and Steel Plant*, has assumed his new duties in the industrial section of the department of publicity of the Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.

IRVING JOHN STAFFORD has resigned his position as assistant superintendent of the No. 2 mill of the Strathmore Paper Co., at Woronoco, Mass., to accept a position as associate engineer in the department of technical control of the American Writing Paper Co., Holyoke, Mass. Prior to his entry into the paper industry, Mr. Stafford was associated with the Dow Chemical Co., Midland, Mich., as manufacturing chemist on electrolytic magnesium.

A. H. TAYLOR, who has been chief of the photometer section of the Bureau of Standards, has resigned to take up a research position with the Nela laboratories, where he will be associated with Dr. Luckiesh.

J. VAN ACKEREN, operating superintendent of the Koppers Co., arrived in New York July 28 on the S.S. Noordam from Rotterdam, after a visit of several months in Europe.

Obituary

JAMES MITCHELL, president and organizer of the Alabama Power Co., died at St. James, L. I., on July 22 after a year's illness from paralysis. Mr. Mitchell was born at Pembroke, Canada, fifty-four years ago, but his family moved to Milton, Mass., when he was a boy. As a young man he worked for the Thompson-Houston Co., now part of the Lynn works of the General Electric Co. He was a pioneer in electric railway development in South America, but during the past decade had devoted his time to his greatest work, the Alabama Power Co. Besides his widow, Mr. Mitchell is survived by two children, John Malcolm, a junior at Cornell, and Miss Marion Mitchell.

LUDWIG GATTERMANN, professor of chemistry at Freiburg, died on June 20, 1920. He was born in April, 1860, studied chemistry in Göttingen and was for a time assistant to Victor Meyer at Göttingen and later at Heidelberg. In 1900 he became professor of chemistry at the University of Freiburg. He contributed greatly to the development of organic chemistry. Among his most important works are: "Electrolytic Reduction of Aromatic Nitrogen Compound," "On Aromatic Thioketones," "Direct Synthesis of Aromatic Aldehyde," "Chemistry of Silicon," "Dyes and Other Derivatives of Anthraquinone" and a textbook on "Practical Methods of Organic Chemistry."

Current Market Reports

The Iron and Steel Market

Pittsburgh, July 30, 1920.

Rail transportation conditions, as regards the shipment of pig iron and steel products, have rounded the turn. The point is well passed at which the rate of pig iron and steel accumulating at works ceased to increase and the point has probably been reached, or at least closely approached, at which the total of accumulations is not increasing. The next period would be one of gradually moving the accumulations in addition to moving the current production. In the Chicago district there has already been somewhat of a clean-up, whereby the stocks of accumulated material are greatly reduced. In the Pittsburgh and Youngstown districts the shipments are still short of production, but not by as large a margin as formerly, and not a few mills have in the past week shipped approximately as much as they produced. The shipments do not invariably represent the current production, for some mills are shipping finished products from stock and at the same time accumulating semi-finished material, the object being to make the stocks of more mobile character, it being recognized that some of the finished steel made lately to customers' specifications would not be acceptable if not shipped until its turn came.

COAL CAR OUTLOOK BETTER

As noted in the last report, iron and steel interests were entertaining the hope that within a short time the coal mines will be supplied with as many cars as they were able to load, whereupon any further increase in transportation would permit of more transportation being given to the iron and steel industry. Evidences are accumulating that the point is near at hand. One coal operator in the Pittsburgh district, for illustration, has admitted that with his present 70 per cent car supply he is loading all the coal his miners will produce. They could produce more if they worked full time, but that they will not do as a rule, when the tonnage rate is where it stands.

There is no question that the railroads as a whole are functioning better from week to week, whereby the total

volume of transportation is increasing. It is a case of reducing inefficiency of the physical equipment, not of additions to equipment. There will be additions in future, but no large additions in the nearby future. The iron and steel industry is convinced that the railroads are not operated as efficiently as they could or should be. This judgment is supported by various comparisons, one of these being that certain roads which in the past were considered rather poorly equipped physically and mentally are now functioning much better than other roads that have had very good reputations.

Transportation and Steel Consumption

The steel industry considers transportation the most vital factor, or at least one of the two most vital factors in the matter of steel trade prosperity. Better transportation conditions are wanted not merely for the sake of steel products being moved to customers with more facility, but largely for the sake of steel consumers and potential consumers receiving such transportation service upon their other raw materials or upon their finished products that they will have occasion to operate at better rates and thus have greater use for steel.

The other of the two most important factors bearing upon the nearby future of the steel trade is the matter of money and credit. With the present strained financial situation there is no room for sufficient initiative in the undertaking of large construction work, and this applies to the construction of railroad facilities as well as of other things. In the conduct of the present steel business there is no lack of money apparent, but expansion is prevented. The pig iron and steel producers are carrying little if any paper of their customers, payments being good, nor are the producers borrowers to any extent. The business that is being done is financed without any difficulty, but growth in demand is restricted by present financial conditions.

Quiet Markets

The pig iron, semi-finished steel and finished steel markets have all been very quiet in the past week, even quieter than in previous weeks of the proverbially dull midsummer period. There is no definite trend by which the future can be gaged. With such a light demand for steel one might expect steel prices to decline, and undoubtedly many buyers do entertain such an expectation. Pir iron, however, is high relative to steel prices, and yet pig iron, as quotable in the open market, is displaying a distinct advancing tendency. Bessemer, basic and foundry iron in the local market are all quotable $1 a ton higher, at $47 for bessemer and $46 for basic and foundry, f.o.b. valley furnaces. The advances have occurred through there being insistent demand for relatively small lots of prompt iron, when it is the delivery rather than the iron that the purchaser is buying, for the purchaser may indeed have considerable tonnages of iron due him on old and lower priced contracts, the iron not being shipped because cars are not available or because the furnace has had its output restricted by coke scarcity.

In prices for finished steel products for prompt shipment there has been a gradual lowering for many weeks past, prompt prices tending to reach the level of prices for deliveries within a few months. While this trend continues, in general, sheets have had a movement of their own and are higher priced for prompt shipment than a fortnight ago.

The Chemical and Allied Industrial Markets

New York, July 30, 1920.

The chemical market is in the grip of the usual dull midsummer season. Very few inquiries are heard and as a result the market for the most part remains in the same position as previously reported. It is noticeable, however, that this condition is having a salutary effect upon the trade as a whole, as it gives producers a chance to catch up on some of their overdue contracts, and dealers will be better able to meet the fall buying season when it arrives. The *acids* have remained quiet during the week, the only change being in *citric*, which is held firm by producers at 80c. in car lots and 82@84c. in less than car lots. Most of actual trading in *alum* recently is resale, quotations running at 6@6½c. per lb., while the manufacturers' price has continued at 4½c. With the increase in the cost of production, however, the leading concerns have advanced their quotations to 5@5½c. for *ammonia lump* and 8@8¾c. for *potash lump*, while *chrome lump* holds firm at previous levels of 15¼@18c. per lb. for car lots. As was noted some weeks ago, the *barium chloride* situation seemed to be becoming easier and with the arrival of fresh supplies in this market the quotation has come down from a nominal figure of $170@$180 per ton to an actual figure of $160, at which price there were actual orders placed during the week. *Copperas* also came down and although there is not enough material on spot to meet the demand the current quotation is $2.20@$2.50 per cwt., against $2.75@$3, the recently prevailing price. *Potassium salts* remained firm in general with *chlorate* advanced to 19@19½c. per lb., due principally to the difficulty manufacturers are experiencing in increased plant expenses.

Coal-Tar Products

This market seems to have assumed a healthier tone, although there has not been any noticeable upward price movement. The reason for this is larger supplies. The present dullness caused by the dropping out of the buying market of tanners and textile interests is rather an advantage to coal-tar producers, giving them the opportunity to catch up in their contracts. *Napththalene* is the exception, as no material in even medium sized quantities is available. Resale lots are still changing hands at figures ranging between 19c. and 21c. per lb. The improvement in supplies of *dinitrotoluol* has caused a slight drop in this item, which can be had at 35@40c. per lb., against 40@45c. of the previous week. *H acid* can also be obtained in larger quantities, with $2@$2.25 per lb. the prevailing quotations, and *orthonitrotoluol*, which has been quiet for some time, is listed at 35@40c. per lb.

Naval Stores

Quotations on *rosins* are the same as last reported, although there was considerable activity the first part of the week and there was a general advance of about 30c., but during the last few days the tone of the market has weakened and today the former prices prevail. *Turpentine* fared a little better, making an advance of 11c. and keeping in that position, current quotation now being about $1.69 per gal., and this is practically a nominal figure, as there is scarcely any material available in the local market.

Oils

The prevailing dullness in this market remains unbroken. Buying interest in *cottonseed* is quiet and evidently awaiting a price readjustment on the new seed. Current quotation is $13.40@$14. There has been a firmer tone manifested in *soya bean* during the week, although business is by no means near normal at the prevailing figure of 10¾c. per lb. *Peanut* oil is one of the weakest items on the list, inquiries being few. Offerings continue in small way on a 12¼@12½c. per lb. basis.

The Baltimore Market

Baltimore, Md., July 29, 1920.

The fertilizer manufacturers are now beginning to show more interest in the purchase of their supplies for the fall as well as next spring season. Labor conditions are still very unsatisfactory, with no indications of any improvement, and it is the consensus of opinion of the manufacturers that they will experience considerable difficulty during the next few months in getting enough cars to ship their products.

During the past week the market on cottonseed meal has eased up, and this material is now obtainable for summer as well as fall shipments at less than tankage, even without taking into consideration the value of phosphoric acid and potash in cottonseed meal. Off-grade meal for August shipment is quoted as low as $8 per unit of ammonia delivered Baltimore, no charge for phosphoric acid, potash or bags. Prime 43 per cent meal is being quoted for September-December shipment from the South at $8.25@$8.50 per unit of ammonia. Figuring the value of phosphoric acid, potash and bags, this brings the ammonia down to the basis of about $7.60@$7.85 per unit.

The acid phosphate market during the next few months is closely sold up, and on account of the car situation, producers are not disposed to commit themselves to too heavy a tonnage to move by cars, even during the later months. Prices remain unchanged at $20 per ton for 16 per cent grade, in bulk, with run of pile testing 17 to 18 per cent being quoted at $19.50 per ton of 2,000 lb., in bulk, basis 16 per cent. It is not so much a question of price with the producers as it is of being able to fill the orders and take care of their regular trade. There is no improvement in the phosphate rock situation, and occasional resale lots are readily taken up with prices ranging from $15 to $16 per gross ton ex vessels Baltimore. Sulphuric acid is also in short supply, and when all conditions are taken into consideration, it can be readily understood that the present market will be maintained for some months to come.

Tankage

There is practically none of this material now finding its way from the West to this section, as the fertilizer manufacturers realize it is impossible for them to compete for the desired makes with buyers who require this material for feeding purposes. The Eastern market remains unchanged, and prevailing price of $8 per unit of ammonia and 10c. per unit of B.P.L., basic c.a.f. Baltimore, is still considered a shade under the market, but business can be worked at this figure. Some of the producers have their views pitched at this price f.o.b. shipping point, but buyers are slow to take hold at this figure.

Nitrate of Soda

This article has been somewhat more active than for some time past, and with the falling sterling exchange, it is possible to shade $4 per 100 lb. for October-December arrivals, and $4.10 for January-April arrivals. However, any material improvements in the exchange situation will naturally be reflected in importers' prices.

Potash

During the past week there has been considerable agitation over the fact that the German syndicate is trying to hold up the American buyers by charging them twice as much for potash as they sell to other countries. While there is no concerted action on the part of American fertilizer manufacturers, at the same time they have been strongly advised to defer the purchase of their requirements of potash over the remainder of this year another thirty days at least, which is felt will have the desired effect on the German Government, which from reports has already been bringing pressure to bear on the syndicate to reduce prices to an equitable basis in order to move a good tonnage. Up to the present time only about one-fifth of the tonnage of German potash has been shipped since April 5 that would have been shipped had prices been on a reasonable basis. Spot stocks, however, are being firmly held on the basis of $2.20@$2.25 per unit for kainit and $2.65 for muriate, with no manure salt offering and no important shipments on the way. The demand, however, is very light, as fall mixtures are usually much lower in potash than during the spring season.

Fish Scrap

The catch of fish in the Chesapeake Bay remains moderate and stiffening up in prices is noticeable, while the nominal market is $7.50 and 10c. for dry scrap f.o.b. factories. This price is subject to catch and "if made." Producers are well sold up and every indication points to the fish factories having a banner season.

Bone Meal

There is no change in the market, which is practically bare of both raw and steamed bone meal, 3 and 50 per cent still being held at $54 per ton, in buyers' bags, f.o.b. Baltimore, and every indication points to this price being maintained. Raw bone meal is a trifle firmer and very scarce; resale lots now being held at $64 per ton in second-hand bags f.o.b. basis Baltimore.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	.....	$0.65 – $0.75
Acetone	lb.	$0.15 – $0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 3.75	4.00 – 4.50
Acetic, 56 per cent	cwt.	6.50 – 7.50	8.50 – 9.50
Acetic, glacial, 99½ per cent. arboy	cwt.	16.20 –	16.25 – .....
Boric, crystals	lb.	.15 – .15½	.16 – .19
Boric, powder	lb.	.15 – .15½	.16 – .20
Citric	lb.	.78 – .80	.82 – .84
Hydrochloric (nominal)	cwt.	2.00 – 3.00	3.10 – 4.00
Hydrofluoric, 52 per cent	lb.	.13½ – .14	.14½ – .15½
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		.....	.....
Nitric, 40 deg	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.55 – .57	.60 – .65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 – .23	.24 – .25
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.25 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 – 16.00	.....
Sulphuric, 60 deg., drums	ton	.....	.....
Sulphuric, 66 deg., tank cars	ton	16.00 – 17.00	18.00 – 20.00
Sulphuric, 66 deg., drums	ton	26.00 – 28.00	.....
Sulphuric, 66 deg., carboys	ton	.....	.....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	37.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	38.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 – .....
Tannic, U. S. P	lb.	1.45 – 1.50	1.55 – 1.65
Tannic (tech.)	lb.	.60 – .70	.80 – .90
Tartaric, crystals	lb.	.....	.74 – .77
Tungstic, per lb. of WO	lb.	.....	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl, 95%	gal.	.....	3.25 – 3.30
Alcohol, Methyl, pure	gal.	.....	3.50 – 3.55
Alcohol, denatured, 188 proof (nominal)	gal.	.....	1.10 – 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	.....	1.05 – 1.10
Alum, ammonia lump	lb.	.05 – .05½	.05½ – .06
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15½ – .18	.19 – .20
Aluminum sulphate, commercial	lb.	.04½ –	.....
Aluminum sulphate, iron free	lb.	.06 –	.....
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09½ – .10¾	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.34 – .35	.35 – .40
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 – .13½	.13½ – .14½
Ammonium nitrate	lb.	.09 – .10	.11 – .14
Ammonium sulphate	lb.	.07 – .07½	.08½ – .....
Amylacetate	gal.	.....	5.00 – .....
Amylacetate tech	gal.	.....	4.75 – 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.15½ – .16	.16½ – .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 – .21	.22 – .25
Barium chloride	ton	150.00 – 160.00	.....
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.09½ – .11	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calcium hypochlorite)		.....	.....
Blue vitriol (see copper sulphate)		.....	.....
Borax (see sodium borate)		.....	.....
Brimstone (see sulphur, roll)		.....	.....
Bromine	lb.	.70 – .90	1.00 – 1.05
Calcium acetate	cwt.	3.50 – 3.55	.....
Calcium carbide	lb.	.04½ – .04½	.04¾ – .05½
Calcium chloride, fused, lump	ton	25.00 – 30.00	35.00 – 45.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .03½
Calcium hypochlorite (bleaching powder)	cwt.	.....	4.50 – 6.50
Calcium peroxide	lb.	.....	1.50 – 1.70
Calcium phosphate, monobasic	lb.	.....	.75 – .80
Calcium sulphate, pure	lb.	.....	.25 – .30
Carbon bisulphide	lb.	.08 – .09	.10 – .11
Carbon tetrachloride, drums	lb.	.14 – .15	.16 – .17
Carbonyl chloride (phosgene)	lb.	.....	.80 – 1.05
Caustic potash (see potassium hydroxide)		.....	.....
Caustic soda (see sodium hydroxide)		.....	.....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	.30 – .35	.36 – .38
Cobalt oxide	lb.	.....	2.00 – 2.05
Copperas (see iron sulphate)		.....	.....
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	.....	.65 – .70
Copper sulphate, crystals	lb.	.08 – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		.....	.....
Epsom salt (see magnesium sulphate)		.....	.....
Ethyl Acetate Com. 85%	gal.	1.35 –	1.40 – .....
Ethy Acetate pure (acetic ether 98% to 100%)		.....	1.75 – .....
Formaldehyde, 40 per cent (nominal)	lb.	.....	.57 – .65
Fusel oil, ref	gal.	.....	5.25 – 6.00
Fusel oil, crude (nominal)	gal.	.....	.....
Glauber's salt (see sodium sulphate)		.....	.....
Glycerine	lb.	.....	.26½ – .28
Iodine, resublimed	lb.	4.30 – 4.35	4.40 – 4.45
Iron oxide, red	lb.	.....	.03 – .20
Iron sulphate (copperas)	cwt.	.....	2.20 – 2.50
Lead acetate, normal	lb.	.....	.13½ – .16
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	.....	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	.....	1.50 – .....
Magnesium carbonate, technical	lb.	.12 – .14	.15 – .17
Magnesium sulphate, U. S. P	100 lb.	3.00 – 3.55	4.00 – 4.50
Magnesium sulphate, commercial	100 lb.	.....	3.25 – 3.50
Nickel salt, double	lb.	.....	.14 – .17
Nickel salt, single	lb.	.....	.13 – .17
Phosgene (see carbonyl chloride)		.....	.....
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	.....	.35 – .37
Potassium bichromate	lb.	.50 – .55	.57 – .60

		Carlots	Less Carlots
Potassium bitartrate (cream of Tartar)	lb.	$0.52 – $0.56	$0.57 – $0.58
Potassium bromide, granular	lb.	–	.90 – .95
Potassium carbonate, U. S. P.	lb.	–	.47 – .50
Potassium carbonate, crude	lb.	.20 – .25	.26 – .28
Potassium chlorate, crystals	lb.	.17 – .17½	.18 – .20
Potassium hydroxide (caustic potash)	lb.	.30 – .33	.35 – .38
Potassium iodide	lb.	–	3.35 – 3.60
Potassium nitrate	lb.	.17 – .17½	.19 – .21
Potassium permanganate	lb.	.75 – .80	.85 – .95
Potassium prussiate, red	lb.	.90 – 1.00	1.05 –
Potassium prussiate, yellow	lb.	.32 – .36	.35 – .40
Potassium sulphate (powdered)	ton	$225.00 – 240.00	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake	ton	–	40.00 – 50.00
Silver cyanide (nominal)	oz.	–	1.25 –
Silver nitrate (nominal)	oz.	–	.63 – .70
Soda ash, light	100 lb.	–	3.20 – 3.50
Soda ash, dense	100 lb.	–	3.55 – 3.65
Sodium acetate	lb.	–	.10 – .15
Sodium bicarbonate	100 lb.	2.50 – 2.75	3.00 – 3.50
Sodium bichromate	lb.	.22 – .24	.26 – .27
Sodium bisulphate (nitre cake)	ton	7.00 – 8.00	9.00 – 11.00
Sodium bisulphite Powered, U.S.P.	lb.	.08½ –	.10 – .11
Sodium borate (borax)	lb.	.09 – .10	.11 – .12
Sodium carbonate (sal soda)	100 lb.	1.50 – 1.80	1.80 – 2.00
Sodium chlorate	lb.	.11 – .12	.12½ – .13
Sodium cyanide, 96-98 per cent	lb.	.25 – .30	.32 – .35
Sodium fluoride	lb.	.18 –	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	–	6.25 – 7.00
Sodium hyposulphite	lb.	–	.03 – .04
Sodium molybdate	lb.	2.50 –	3.25¾ –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.16 – .18	.19 – .20
Sodium peroxide, powdered	lb.	.32 – .35	.35 – .40
Sodium phosphate, dibasic	lb.	.03¾ – .04½	.04¼ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.39 – .40
Sodium prussiate, yellow	lb.	.23 – .27	.31 – .32
Sodium silicate, solution (40 deg.)	lb.	.01¼ – .01¼	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 – 1.70	1.75 – 2.50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.09½ – .10	.10½ – .11
Sodium sulphite, crystals	lb.	.04 – 0.4½	.04½ – .05
Strontium nitrate, powdered	lb.	.17½ – .18½	.19 – .20
Sulphur chloride red	lb.	.08 – .09	.10 – .10½
Sulphur, crude	ton	25.00 – 30.00	–
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	–	3.80 – 4.35
Sulphur, roll (brimstone)	100 lb.	–	3.40 – 3.90
Tin bichloride (stannous)	lb.	.42½ – .44	.45 – .46
Tin oxide	lb.	–	–
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.13 – .13½	.13½ – .17
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.11 – .12	.12 – .13
Zinc oxide, U. S. P.	lb.	.17 – .25	–
Zinc sulphate	lb.	.03½ – .03¾	.04 – 06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.40 —	$1.50
Alpha naphthol, refined	lb.	1.60 —	1.70
Alpha naphthylamine	lb.	.53 —	.55
Aniline oil, drums extra	lb.	.33 —	.34
Aniline salts	lb.	.40 —	.42
Anthracine, 80% in drums (100 lb.)	lb.	.90 —	1.00
Benzaldehyde (f.f.c.)	lb.	2.00 —	2.10
Benzidine, base	lb.	1.35 —	1.40
Benzidine, sulphate	lb.	1.15 —	1.25
Benzoic acid, U.S.P.	lb.	.90 —	1.00
Benzoate of soda, U.S.P.	lb.	.80 —	.90
Benzol, pure, water-white, in drums (100 lb.)	gal.	.35 —	.40
Benzol, 90%, in drums (100 lb.)	gal.	.33 —	.38
Benzyl chloride, 95-97%, refined	lb.	.35 —	.40
Benzyl chloride, tech	lb.	.25 —	.35
Beta naphthol benzoate (nominal)	lb.	3.50 —	4.00
Beta naphthol, sublimed (nominal)	lb.	–	–
Beta naphthol, tech (nominal)	lb.	.85 —	.95
Beta naphthylamine, sublimed	lb.	2.25 —	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 —	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23 —	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.05 —	1.15
Cresylic acid, 95-97%, dark, in drums	gal.	1.00 —	1.05
Cresylic acid, 50%, first quality, drums	gal.	.65 —	.75
Dichlorbenzol	lb.	.08 —	.10
Diethylaniline	lb.	1.50 —	1.60
Dimethylaniline	lb.	1.35 —	1.45
Dinitrobenzol	lb.	.30 —	.32
Dinitroclorbenzol	lb.	.32 —	.35
Dinitronaphthaline	lb.	.45 —	.55
Dinitrophenol	lb.	.40 —	.45
Dinitrotoluol	lb.	.35 —	.40
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 —	.40
Diphenylamine (nominal)	lb.	.80 —	.85
H-acid (nominal)	lb.	2.00 —	2.25
Metaphenylenediamine	lb.	1.25 —	1.30
Monochlorbenzol	lb.	.18 —	.20
Monoethylaniline	lb.	2.00 —	2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	–	–
Naphthaline, flake	lb.	–	.19
Naphthaline, balls	lb.	–	.19
Naphthionic acid, crude	lb.	.75 —	.85
Nitrobenzol	lb.	.14 —	.19
Nitro-naphthaline	lb.	.40 —	.50
Nitro-toluol	lb.	.18 —	.25
Ortho-amidophenol	lb.	3.25 —	4.25
Ortho-dichlor-benzol	lb.	.15 —	.20
Ortho-nitro-phenol	lb.	.80 —	1.25
Ortho-nitro-toluol	lb.	.25 —	.40
Ortho-toluidine	lb.	.35 —	.40
Para-amidophenol, base	lb.	2.50 —	3.00
Para-amidophenol, HCl	lb.	2.50 —	3.00
Para-dichlor-benzol	lb.	.08 —	.12
Paranitraniline	lb.	1.35 —	1.40
Para-nitro-toluol	lb.	1.35 —	1.50
Paraphenylenediamine	lb.	2.50 —	2.65
Paratoluidine	lb.	2.00 —	2.25
Phthalic anhydride	lb.	.60 —	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 —	.20
Pyridin	gal.	2.00 —	3.50
Resorcin, technical	lb.	4.25 —	4.50
Resorcin, pure	lb.	6.25 —	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50 —	.52
Salicylic acid, U. S. P.	lb.	.50 —	.60
Salol	lb.	.90 —	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.33½ —	.35½
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.23 —	.26
Sulphanilic acid, crude	lb.	.32 —	.35
Toluidine	lb.	1.70 —	2.50
Toluidine, mixed	lb.	.45 —	.55
Toluol, in tank cars	gal.	.35 —	–
Toluol, in drums	gal.	.38½ —	.40½
Xylidine, drums, 100 gal.	lb.	.50 —	.65
Xylol, pure, in drums	gal.	.37 —	.45
Xylol, pure, in tank cars	gal.	.35 —	–
Xylol, commercial, in drums, 100 gal.	gal.	.37 —	.45
Xylol, commercial, in tank cars	gal.	.23 —	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36 —	$0.39
Beeswax, refined, light	lb.	.39 —	.40
Beeswax, white pure	lb.	.63 —	.68
Carnauba, No. 1. (nominal)	lb.	1.00 —	1.05
Carnauba, No. 2, regular (nominal)	lb.	.85 —	.88
Carnauba, No. 3, North Country	lb.	.35 —	.36
Japan	lb.	.19 —	.19½
Montan, crude	lb.	.23 —	.25
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09 —	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.10 —	.10½
Paraffine waxes, refined, 118-120 m.p.	lb.	.11½ —	.12
Paraffine waxes, refined, 125 m.p.	lb.	.12½ —	–
Paraffine waxes, refined, 128-130 m.p.	lb.	.14½ —	.15½
Paraffine waxes, refined, 133-135 m.p.	lb.	.16½ —	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½ —	.18½
Stearic acid, single pressed	lb.	.24 —	.25
Stearic acid, double pressed	lb.	.25 —	.26
Stearic acid, triple pressed	lb.	.27 —	.28

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$2.30
Pine oil, pure, dest. dist.	gal.	1.80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	2.00
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$12.25 —	$16.25
Rosin E-I	280 lb.	16.60 —	16.75
Rosin K-N	280 lb.	17.00 —	17.20
Rosin W. G.-W. W.	280 lb.	17.25 —	17.50
Wood rosin, bbl.	280 lb.	15.00 —	–
Spirits of turpentine	gal.	1.69 —	–
Wood turpentine, steam dist.	gal.	– —	–
Wood turpentine, dest. dist.	gal.	– —	–
Pine tar pitch, bbl.	200 lb.	– —	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50 —	15.00
Retort tar, bbl.	500 lb.	15.00 —	15.50
Rosin oil, first run	gal.	.70 —	–
Rosin oil, second run	gal.	.73 —	–
Rosin oil, third run	gal.	.92 —	–

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.32 —	$0.33
Upriver coarse	lb.	.23 —	.24
Upriver caucho ball	lb.	.23 —	.24
Plantation—First latex crepe	lb.	.32½ —	–
Ribbed smoked sheets	lb.	.31½ —	–
Brown crepe, thin, clean	lb.	.30 —	–
Amber crepe No. 1	lb.	.30 —	–

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.17 —	$0.18
Castor oil, AA, in bbls.	lb.	.19 —	–
China wood oil, in bbls.	lb.	.18½ —	.19
Cocoanut oil, Ceylon grade, in bbls.	lb.	.16 —	–
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.17½ —	.17½
Corn oil, crude, in bbls.	lb.	.16 —	.16½
Cottonseed oil, crude (f.o.b. mill)	lb.	.10 —	.11
Cottonseed oil, summer yellow	lb.	.13½ —	.14½
Cotconseed oil, winter yellow	lb.	.19 —	–
Linsed oil, raw, car lots (domestic)	gal.	1.20 —	–
Linseed oil, raw, tank cars (domestic)	gal.	1.30 —	–
Linseed oil, boiled, car lots (domestic)	gal.	1.35 —	–

Olive oil, commercial	gal.	3.00 —	3.10
Palm, Lagos	lb.	.10½ —	.....
Palm, bright red	lb.	.10½ —	.....
Palm, Niger	lb.	.11 —	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.12½ —	.12½
Peanut oil, refined, in bbls	lb.	.17 —	.18
Rapeseed oil, refined in bbls	gal.	1.65 —	.....
Rapeseed oil, blown, in bbls	gal.	1.70 —	.....
Soya bean oil (Manchurian), in bbls, N. Y.	lb.	.14 —	.14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10½ —	.11

FISH

Winter pressed Menhaden	gal.	$0.90 —	$1.05
Yellow bleached Menhaden	gal.	0.95 —	1.05
White bleached Menhaden	gal.	1.00 —	1.25
Blown Menhaden	gal.	1.00 —	1.20

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00 —	$25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00 —	20.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	8.00 —	10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00 —	25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00 —	19.00
Barytes, crude, 88% @ 94% ba., Cartersville	net ton	12.00 —	.....
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00 —	11.25
Blanc fixe, dry	lb.	.05½ —	.06
Blanc fixe, pulp	net ton	60.00 —	80.00
Casein	lb.	.15 —	.18
Chalk, domestic, extra light	lb.	.05 —	.06
Chalk, domestic, light	lb.	.04½ —	.05½
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00 —	12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (Kaolin), imported, lump	net ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	net ton	30.00 —	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50 —	8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	20.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	20.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00 —	.....
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00 —	.....
Fuller's earth, imported, powdered	net ton	35.00 —	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	..... —	.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	..... —	.02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.	..... —	.05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	..... —	.10
Graphite, crucible, 85% carbon	lb.	..... —	.08
Graphite, crucible, 88% carbon	lb.	..... —	.09½
Graphite, crucible, 90% carbon	lb.	..... —	.10½
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic, lump	lb.	.05 —	.....
Pumice stone, ground	lb.	.04 —	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	..... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	..... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	..... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	Lb.	1.35 —	.....
Shellac, orange superfine	Lb.	1.45 —	.....
Shellac, A. C. garnet	Lb.	1.05 —	1.15
Shellac, T. N.	Lb.	1.20 —	1.30
Soapstone	ton	15.00 —	25.00
Talc, paper-making grades, f.o.b. Vermont	ton	9.50 —	14.00
Talc, roofing grades, f.o.b. Vermont	ton	8.00 —	9.00
Talc, rubber grades, f.o.b. Vermont	ton	9.00 —	15.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00 —	15.00
Talc, imported	ton	60.00 —	70.00
Talc, California Talcum Powder grade	ton	20.00 —	35.00

Refractories

Chrome brick, f.o.b. Chester, Pa., carlots	net ton	90 —	100
Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore	net ton	90 —	95
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45 —	53
Fire clay brick, 1st quality, f.o.b. St. Louis	1,000	45 —	.....
Fire clay brick, 1st quality, f.o.b. New Jersey	1,000	75 —	.....
Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	40 —	.....
Magnesite brick, 9 in. straights, f.o.b. Baltimore	net ton	100 —	.....
Magnesite brick, 9-in. sizes and shapes larger than 9-in.		Regular extras	
Magnesite brick, f.o.b. Chester	net ton	90 —	100
Silica brick, 9-in. and 9-in. sizes, Chicago district	1,000	55 —	.....
Silica brick, f.o.b. Birmingham	1,000	51 —	55
Silica brick, f.o.b. Mt. Union, Pa.	1,000	50 —	55

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	17 —	18
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	19 —	20
Ferro-manganese, 76-80% Mn	gross ton	200.00 —	225.00
Spiegeleisen, 18-22% Mn	gross ton	75.00 —	.....
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.50 —	3.00
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00 —	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	1.10 —	1.15
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	.....
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50 —	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60	.65
Chrome ore, 40%, min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.77 —	.85
*Coke, foundry, f.o.b. ovens	net ton	18.50 —	20.00
*Coke, furnace, f.o.b. ovens	net ton	18.00 —	19.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	.....
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50 —	.....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	..... —	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.02 —	.....
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.72½ —	.75
Manganese ore, chemical (MnO_2)	gross ton	75.00 —	85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.60 —	.65
Monazite, per unit of ThO_2	unit	42.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½ —	.....
Pyrites, Spanish, run of mines, c.i.f., Atlantic seaport	unit	.12 —	.14
Pyrites, domestic, fines	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	.....
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 —	.....
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	6.50 —	7.50
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75 —	3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 —	.....
Zircon, washed, iron free	lb.	.10 —	.....

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	19.00
Aluminum, 98 to 99 per cent	33.00
Antimony, wholesale lots, Chinese and Japanese	8.00
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	49.50
Lead, New York, spot	9.25
Lead, E. St. Louis, spot	8.90
Zinc, spot, New York	8.25
Zinc spot, E. St. Louis	7.90@8.40

OTHER METALS

Silver (Commercial)	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.70
Cobalt	lb.	2.50@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	80@85
Iridium	oz.	350.00
Palladium	oz.	80.00
Mercury	75 lb.	88.00@96.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	25.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	23.00@23.50
Aluminum, sheet scrap	23.00@23.50
Copper, heavy machinery comp.	14.50@15.00
Copper, heavy and wire	15.50@15.75
Copper, light and bottoms	13.75@14.25
Copper, heavy cut and crucible	16.25
Brass, heavy	9.50@10.00
Brass, light	7.25@7.75
No. 1 clean brass turnings	9.00@9.50
No. 1 comp. turnings	12.50@13.50
Lead, tea	4.75@5.00
Lead, heavy	7.25@7.50
Zinc, scrap	5.00@5.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$4.47	$3.97	$3.47	$5.00	$3.37	$3.97	$3.47
Soft steel bars	4.62	4.12	3.37	4.50	3.27	3.87	3.37
Soft steel bar shapes	4.62	4.12	3.37		3.27	3.87	3.37
Soft steel bands	6.32	5.32	4.07	6.25			
Plates, ¼ to 1 in. thick	4.68	4.17	3.67	4.50	3.57	4.17	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Amer. Bolt Wks., 39th St. and 10th Ave. N., has awarded the contract for the construction of a steel addition to forge shops, to C. M. Allen. Estimated cost, $25,000.

Arizona

MESA—The South Side Community Hospital, c/o Berlin, Swern & Randall, archts., 19 South La Salle St., Chicago, is having preliminary plans prepared for the construction of a 3-story, 42x100-ft. hospital. A small chemical laboratory will be installed in same. Estimated cost, $125,000.

Connecticut

BRIDGEPORT — The Amer. Tube & Stamping Co., 471 Hancock Ave., will build a 1-story, 50x160-ft. annealing building on Wordin Ave. Estimated cost, $30,000. Work will be done by day labor.

SUFFIELD — The Fords Wawbeek Springs, Inc., c/o Walter E. Dibble, archt., 317 Main St., Springfield, Mass., will soon award the contract for a 1- and 2-story spring water plant. Estimated cost, $50,000.

WATERBURY—M. J. Daly & Sons, 543 Bank St., has awarded the contract for the construction of a 1- and 3-story factory for the manufacture of sheet metal, to the G. S. Chatfield Co., 138 Division St. Estimated cost, $85,000.

WATERVILLE—The Berbecker & Rowland Mfg. Co., Main St., has awarded the contract for the construction of a 3-story, 40x180-ft. factory for the manufacture of metal goods, to the Torrington Bldg. Co., 197 Water St. Estimated cost, $100,000.

WINDSOR LOCKS — C. H. Dexter & Sons, Inc., has awarded the contract for altering the present tissue paper manufacturing building, to the Bent-Bartlett Co., 43 Ann St., Hartford. Estimated cost, $20,000.

Georgia

SAVANNAH — The Bd. Educ. plans to build a 3-story, 148-224-ft. school. A chemical laboratory will be installed in same. Estimated cost, about $1,000,000. William B. Ittner, Bd. Educ., St. Louis, Mo., archt.

Illinois

CHICAGO — The Enterprise Paint Mfg. Co., 854 West Van Buren St., has awarded the contract for the construction of a 5-story, 44x60-ft. paint factory on Van Buren and Peoria Sts., to the O. W. Rosenthal Co., 84 East Jackson St. Estimated cost, $50,000.

GRANITE CITY—The Bd. Educ. is having plans prepared for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, $280,000. William B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., archt.

Indiana

GARY—The Universal Slag Brick & Tile Co. is building a 1-story, 100x200-ft. brick plant. Estimated cost, $200,000. Silica, Brick & Eng. Co., engr.

Iowa

DES MOINES—The Mid-West Steel Co., c/o Des Moines Steel Co., 4th St. south of Tuttle St., plans to build a 2-story steel manufacturing plant. Estimated cost, $200,000. J. VanLew, pres.

NEWTON—The Newton Fdry Co. has awarded the contract for the construction of a 2-story, 106x300-ft. foundry, to the A. H. Newman Co., 517 Hubbell Bldg., Des Moines. Estimated cost, $100,000.

Louisiana

NEW ORLEANS—S. Ohnstein will soon award the contract for the construction of a 1-story factory on Colapessa St., for the Union Paper Products Co., 109 Tchoupitoulas St. Estimated cost, $125,000. Emile Weil, Whitney Central Bank Bldg., archt.

Maryland

BALTIMORE — The Natl. Bitulithic Enamel & Paint Co., Lawrence and Woodall Sts., will receive bids about Aug. 9 for the construction of a 3-story, 100x150 ft. addition to the enamel and paint plant. Estimated cost, $100,000. J. R. Broderich, mgr.

Massachusetts

EAST EVERETT—The Boston Varnish Co., 2d St., has awarded the contract for the construction of a 1-story, 40x60-ft. addition and altering the present plant on East Summer St., to J. E. Locatelli Co., Inc., 46 Cornhill St., Boston. Estimated cost, $30,000. Noted July 21.

HOLYOKE—The Hampden Glazed Paper & Card Co., River Side, has awarded the contract for the construction of a 4-story, 92x291 ft. factory on Water St., to the Casper Ranger Constr. Co., 201 Devonshire St., Boston, at $165,000.

WHEELWRIGHT — The George W. Wheelwright Paper Co., 70 Franklin St., Boston, has awarded the contract for the construction of a concrete sedimentation tank at its Hardwick mill, here, to the H. P. Cummings Constr. Co., Ware.

Michigan

DETROIT—The General Forgings Corp., c/o J. D. Edwards, 54 Lafayette Blvd., plans to build a 2-story, 65x210-ft. drop forging shop.

Minnesota

MINNEAPOLIS—The Western Chemical Co. plans to build a 3- to 5-story patent medicine factory on Malcolm Ave. and University Ave., South. Chemical equipment will be installed in same. Estimated cost, from $125,000 to $150,000. A. G. Kranz, Hutchinson, pres. Downs & Eads, 803 Phoenix Bldg., archts.

Missouri

BROOKFIELD—The School Bd. is having preliminary plans prepared for the construction of a 2-story school. General chemical laboratories will be installed in same. Estimated cost, $105,000. A. W. Baker, secy. W. E. Hulse & Co., 309 Securities Bldg., Des Moines, archt. Noted June 30.

ST. LOUIS—The Blanke-Baer Chemical Co., 1710 Morgan St., plans to build a modern factory for the manufacture of jellies and preserves on King's Highway. Estimated cost, $150,000.

New Jersey

EDGEWATER—The United States Aluminum Co. plans to construct a large addition to its plant.

JERSEY CITY—J. T. Ryerson & Sons, manufacturers of steel, 230 West Side Ave., plan to build an addition to their plant. Estimated cost, $50,000.

MONMOUTH JUNCTION—The Alcoholic Products Corp. has awarded the contract for the construction of a plant addition, to Barney Ahlers, 110 West 40th St., New York City. Estimated cost, $50,000.

TRENTON—The Acme Rubber Co., East State St., has awarded the contract for the construction of a 1-story, 90x300-ft. rubber plant addition on East State St., to the N. A. K. Bugbee Co., 206 East Hanover St. Estimated cost, $60,000.

Ohio

CANTON—The Timken Roller Bearing Co., Dueber Ave., plans to build a 1 and 4-story addition to present plant on 18th St., S. W. Estimated cost, $75,000.

CLEVELAND—The Jordan Motor Car Co., 1052 East 152d St., has awarded the contract for the construction of a 2-story japanning building at 1070 East 152d St., to the Hunkin-Conkey Constr. Co., Century Bldg. Estimated cost, $100,000.

CLEVELAND — The U. S. Leather Co., c/o E. B. Cassett, East 13th St. and Euclid Ave., plans to build a 1-story, 160x300-ft. factory on Broadview Rd. Estimated cost, $100,000.

FOSTORIA—The Willys Light Corp., 221 Cherry St., Toledo, has awarded the contract for the construction of a 1 story, 120x241-ft. foundry for the manufacture of iron castings, to H. J. Spieker, Elm and Utica Sts., Toledo. Estimated cost, $125,000.

MARION—George B. Gascoigne, consult. engr., 1446 East 116th St., Cleveland, has been engaged to report upon sewerage and sewage disposal improvements. Estimated cost, $600,000. T. S. Cathers, city engr.

WARREN—The Bd. Educ., c/o J. Buckwalter, has awarded the contract for the construction of a 2-story, 125x150-ft. addition to the East Technical High School, and a 2-story, 110x182-ft. addition to the West Technical High School, to the Shustrump Co., Youngstown. Laboratory equipment will be installed in same. Estimated cost, $850,000. Noted July 28.

Pennsylvania

ELYSBURG—The Bd. Educ. is having plans prepared for the construction of a 2-story, 60x80-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. Richter Lee, 32 South 17th St., Philadelphia, archt.

JOHNSTOWN—The Peris Products Co. has purchased a site on Sheridan Ave., and plans to build a 2-story, 47x157 ft. factory for the manufacture of soap products. Estimated cost, $150,000.

PHILADELPHIA—The Electric Storage Battery, Allegheny and 19th Sts., has awarded the contract for the construction of a number of buildings, including a forming room, pig lead manufacturing building, jars and castings buildings, etc., to William Steele & Sons Co., 16th and Arch Sts.

PITTSBURGH—The Oliver Iron & Steel Co., 10th and Muriel Sts., has awarded the contract for the construction of a 2-story, 28x60-ft. water purification plant which will have a capacity of 20,000 gal. per hour, to the Cuthbert Bros. Co., Bessemer Bldg. Estimated cost, $35,000.

Rhode Island

PROVIDENCE—J. F. Concannon, Chalkstone Ave., has awarded the contract for the construction of a 1-story, 75x125-ft. laundry, to the Interstate Constr. Co., 29 Weybosset St. Estimated cost, $28,000.

PROVIDENCE — The Franklin Process Co., 29 Promenade St., has awarded the contract for the construction of a 2-story, 110x170-ft. dye house, to J. R. Bickford, 509 Westminister St. Estimated cost, $150,000. Noted July 28.

Tennessee

MEMPHIS—The Continental Piston Ring Co., 650 Marshall St., is building a 150x217-ft. factory.

Texas

HODGE—The Trans-Continental Oil Co. plans to build a wax plant here. Estimated cost, $750,000. W. S. Barwick, supt.

West Virginia

WHEELING—The city plans to install a mechanical filtration system. Estimated cost, $1,500,000.

Wisconsin

CEDARBURG—Fred Schuette, City Clk., will receive bids until Aug. 24 for the installation of 2 sewage disposal tanks, etc.

MILWAUKEE—The Eslein Sheet Metal Wks., 1001 30th St., will build a 1-story, 30x120-ft. sheet metal works addition on 30th St. Estimated cost, $8,000. Work will be done by day labor.

MILWAUKEE — The Patton Paint Co., 213 Lake St., has awarded the contract for the construction of a 2-story, 70x106-ft. varnish factory and a 60x112-ft. warehouse on Lake St., to the Amer. Contg. Co., 198 Milwaukee St. Estimated cost, $180,000. Noted July 7.

SHEBOYGAN—The Tomah Rubber Wks., 176 16th St., Milwaukee, plans to build a 2-story, 80x160-ft. factory for the manufacture of rubber goods.

WAUKESHA—The Waukesha Fdry. Co., 340 B'way, has awarded the contract for the construction of a 1-story, 120x300-ft. foundry, to the Federal Bridge & Structure Co. Estimated cost, $50,000.

WHITEFISH BAY—The city is having plans prepared for the construction of a sewage disposal plant, filter beds of sand and crushed syphons. Estimated cost, $20,000. Parsons & Orbert, 627 M. & M. Bank Bldg., engrs.

Alaska

UNALASKA ISLAND—The Amer. Whale Products Co., 8 South Dearborn St., Chicago, will soon award the contract for the construction of a whale oil plant along Udagak Bay. Plans include refining and fertilizer plants, oil tanks, etc. Estimated cost, $1,000,000. Woltersdorf & Bernard, 138 North La Salle St., Chicago, archts.

Alberta

ATHABASKA — Mackenzie Basin Fisheries will soon receive bids for the construction of a cannery along Black Bay, here. L. Baxter, Sidney, N. S., engr.

Cuba

HAVANA — The Anglo-Saxon Hospital, c/o Berlin, Swern & Randall, archts., 19 La Salle St., Chicago, is having plans prepared for the construction of a 5-story hospital. A chemical laboratory will be installed in same. Estimated cost, $600,000.

Ontario

BRANTFORD—The Cockshut Plow Co. will receive bids until Aug. 8 for the construction of a 70x200-ft. foundry and forging building. Estimated cost, $150,000.

GODERICH — The Town Council is receiving bids for the installation of an automatically controlled chlorinating plant. Mayor Wigle, Chn. of the Committee.

GRIMSBY—The Grimsby Pickle Co. will soon award the contract for the construction of a 3-story, 40x80-ft. pickle factory. Estimated cost, $40,000.

PETROLEA — The Adams Wagon Co. plans to build a 1-story, 70x200-ft. forge shop and is in the market for equipment for same. Estimated cost, $25,000.

SUDBURY—The Canada Creosoting Co. plans to build a 1- and 2-story creosoting plant. Creosoting equipment will be installed in same. Estimated cost, $50,000.

Quebec

MONTREAL—The Canadian Rubber Co., Ltd., Inspector St., has awarded the contract for the construction of a 1-story, 40x50-ft. rubber factory on Notre Dame St., E., to George M. Martin & Co., St. Catherine St., W., Westmount. Estimated cost, $12,000.

Industrial Notes

CANADIAN ABRASIVES, LTD., has been organized with a capital of $100,000, and ground has been broken for the erection of a plant which is to cost $50,000, on Mason St., Victoria. The Provincial Government, through the Department of Industries, has granted the company a loan of $22,000 at 6 per cent interest. The company will manufacture abrasive papers and powders from natural products. At several points in British Columbia there are extensive deposits of high-grade silica and garnet sands.

WILSON-MAEULEN CO., New York City, has appointed S. C. Horn representative for the Cincinnati district, with an office at 311 Commercial Tribune Bldg.

ELECTRIC FURNACE CONSTRUCTION CO., Philadelphia, Pa., announces recent sales of electric furnaces to Dodge, Carrigan & Favorite, of Philadelphia, Pa., and the Electric Steel Products Co., of Turners Falls, Mass.

HAMLIN & MORRISON, Philadelphia, Pa., announce the opening of a branch at 10 East Lexington St., Baltimore, Md., on Aug. 2, 1920, where they will specialize in sampling and weighing. All analytical work will continue to be done at the Philadelphia laboratory.

THE QUIGLEY FURNACE SPECIALTIES CO., New York City, has appointed W. A. Toohill sales representative for the Dayton, Ohio, territory. Mr. Toohill was for some years metallographist with the International Motors Co. at the Plainfield and New Brunswick, N. J., plants of that company.

THE KNOXVILLE IRON & STEEL CO., Knoxville, Tenn., is preparing to use powdered coal for puddling, busheling and reheating furnaces as well as for boilers to replace its present hand-fired method. Contract has been closed with the Quigley Furnace Specialties Co., 26 Cortlandt St., New York City, for a complete system, including coal-milling plant and equipment for distributing and burning the pulverized fuel by the Quigley compressed air system. Work on this installation is to be started immediately.

THE CLEVELAND CRANE & ENGINEERING CO., Wickliffe, Ohio, is publishing a bi-monthly house organ entitled *Crane-ing*. This paper is an intentional effort to create immediate inquiries and subsequent sales for Cleveland cranes, and is a most interesting and well illuminated presentation.

MEIGS, BASSETT & SLAUGHTER, INC., chemical engineer, 210 South 13th St., Philadelphia, Pa., has taken over the interest of Dr. Samuel P. Sadtler in the firm of Samuel P. Sadtler & Son, analytical and research chemist, and has incorporated the same as Samuel P. Sadtler & Son, Inc. Dr. Sadtler is retained as the expert consultant and S. S. Sadtler has been made president, Dr. H. P. Bassett and B. G. Slaughter vice-presidents, and C. C. Meigs secretary and treasurer.

W. S. QUIGLEY, president of the Quigley Furnace Specialties Co., sailed for Europe on the Cunard liner Imperator on July 15. His trip is for the purpose of furthering the business relations of the Quigley organization in England, France, Belgium, Italy and Spain.

THE ANGELUS HEEL & RUBBER CO. is installing new equipment in its factory at 1417 N. Main St., Los Angeles, and in the near future expects to begin the production of rubber tubing, stopples, etc., for the drug and chemical trade of the Pacific Coast. The present output consists chiefly of mechanical goods, especially rubber soles, heels, and valve disks. W. E. McCarty is president and general manager and Emmet Long is factory superintendent.

NEW YORK TESTING LABORATORIES, L. R. Seidell, managing director, has been awarded the contract for the chemcial, physical and electrical testing of approximately 400,000 ft. of fire alarm telegraph and police signaling cable and wire by A. E. Roche, engineer, for the City of Troy, the inspection being under the supervision of G. Brinton Jack, Jr., director of inspection and tests.

Manufacturers' Catalogs

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., is issuing a new two-color, 24-page booklet on elevator controllers. This booklet, which is known as Publication 840, illustrates the new controllers and emphasizes their simplicity, quiet operation and smooth acceleration. Carbon-to-copper standardized power contacts are used, which are interchangeable on a.c. or d.c. controllers of the same rating. Acceleration is obtained by time limit relays of simple design, which furnish the same comfortable smoothness of acceleration in spite of widely varying load conditions. The last few pages are devoted to auxiliary apparatus for use with elevator controllers, which includes reversing switches, floor selectors, various limit switches, car switches and door switches.

THE GRISCOM-RUSSELL CO., New York City, calls attention to Bull. 1111, entitled "Stratton Air Separator," which tells of the successful removal of water from compressed air.

YARNALL-WARING CO., Philadelphia, Pa., has published a folder description of its Yarway pipe-joint and Yarway holtite pipe clamps. It will gladly furnish copies of the folder upon request.

P. H. & F. M. ROOTS CO., Connersville, Ind., has just received from the press Cat. 68, 2nd edition. This attractive 48-page booklet gives descriptions and illustrations of the many types of blowers for foundry cupolas, steel converters, oil furnaces, gas appliances, filtration and agitation, and also tables of sizes of the blowers.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CERAMIC SOCIETY will hold its summer meeting at the La Salle Hotel in Chicago, Aug. 16, 17 and 18.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, at Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PEAT SOCIETY will hold its annual meeting at Madison, Wis., Sept. 2, 3 and 4, 1920.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

New Publications

THE FOREST PRODUCTS LABORATORY, Madison, Wis., announces the following circulars for distribution: Key for the Identification of Native Woods Used for Chairs and Other Furniture; 12 pages and appendix. Glues Used in Airplane Parts; 28 pages, illustrated; report No. 66, prepared for the Naval Advisory Committee for Aëronautics, 1920. The Effect of Kiln Drying on the Strength of Airplane Woods; 69 pages, illustrated; report No. 68, prepared for the Naval Advisory Committee for Aëronautics. Drying Lumber by Means of Superheated Steam; 1 page, with diagram of kiln; reprint from lumber journals. Suitability of Cotton Hull Fiber for Paper Manufacture; 6 pages, 1 chart; reprint from trade journals, April, 1920. Information for Dry Kiln Operators on Drying Hardwoods for Furniture and Similar Products; 14 pages with charts and tables.

THE MELLON INSTITUTE OF INDUSTRIAL RESEARCH of the University of Pittsburgh has issued its seventh annual report on the Industrial Fellowships of the Mellon Institute, by Raymond F. Bacon, director.